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DEVELOPMENT OF TWO TYPES OF VENTILATORS.(U)
APR 79 J M BUDAY, R J KLIMA DCPA01-78-C-0184
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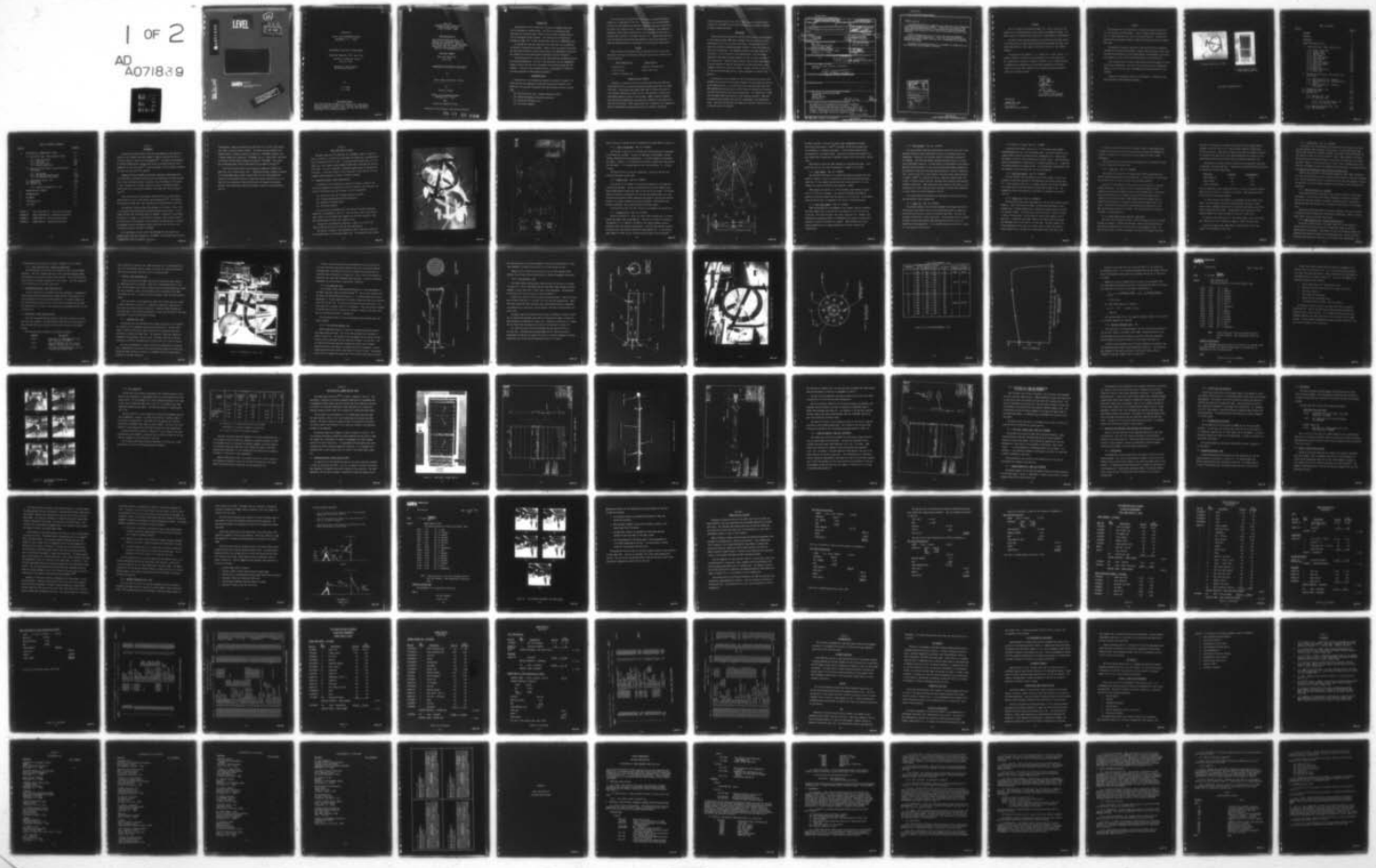

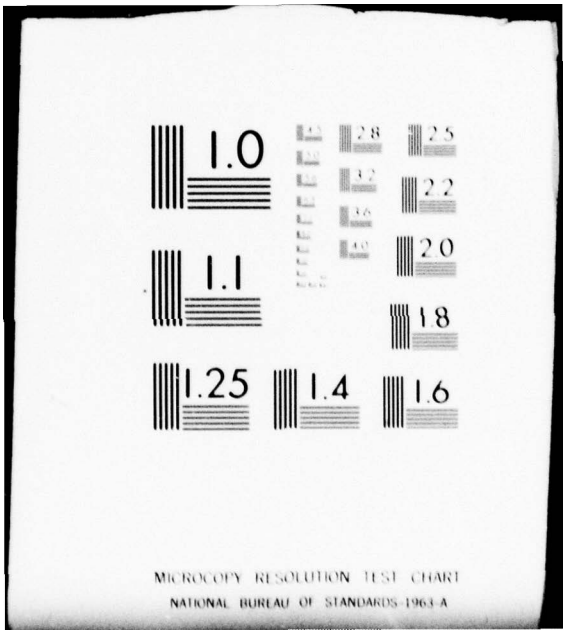
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Prepared for

DEFENSE CIVIL PREPAREDNESS AGENCY
WASHINGTON, D. C. 20301

DEVELOPMENT OF TWO TYPES OF VENTILATORS

GARD FINAL REPORT NO. 1703 April 1979

Contract No. DCPA01-78-C-0184

Work Unit 1423E

Approved for Public Release;
distribution unlimited.

By

J. M. Buday
R. J. Klima

GARD, INC.

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DETACHABLE SUMMARY

GARD FINAL REPORT 1703

April 1979

Development of Two Types of Ventilators

by

John M. Buday and Richard J. Klima

for

Donald A. Bettge

DEFENSE CIVIL PREPAREDNESS AGENCY
Washington, D.C. 20301

under

Contract No. DCPA01-78-C-0184

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INTRODUCTION

The objective of this program was to evaluate two types of ventilator kits for maximum cost effectiveness. The kits evaluated were the pedal ventilator and the Kearny pump. Both kits are designed to provide ventilation of designated fallout shelters. The subject units were previously developed by GARD, INC. in 1969 for DCPA under Contract No. DAHC20-68-C-0123.

An engineering study was conducted on the ventilator kits to determine the potential manufacturing economies. Based on the conclusions of the study, the fabrication drawings, military specifications and deployment instructions were updated to reflect modifications determined to be cost-effective.

Three prototype units of each kit were fabricated and assembled utilizing the revised documentation. One set of the ventilator kits was subsequently tested to assure that the units' performance and reliability were not compromised. Production cost estimates based on a procurement of 10,000 units each were generated for DCPA budgetary purposes.

ENGINEERING STUDY

The objective of the engineering study was to conduct a review of the various PVK and KPK components to determine the areas of potential cost reduction. The study was formulated using the following criteria as guidelines.

(A) Utilize "off the shelf" hardware wherever possible.

(B) Eliminate unnecessary machining operations.

(C) Delete non-functional parts.

(D) Facilitate assembly.

No revisions were considered that would detract from the performance, durability, or deployment of the kits. Since many of the various elements of both kits were commercially available components, they were investigated for source cost comparison only. Based on data compiled in the completed engineering study, GARD incorporated all valid cost-effective revisions to the applicable drawings on the pedal ventilator kit. The Military Specifications and operating instructions were updated to reflect any additions or deletions deemed necessary by the changes in the PVK design configuration.

TESTING

GARD performed the following tests on the PVK and KPK to assure that the overall functional performance of the units had not been violated by the revised components.

Pedal Ventilator Kit	Kearny Pump Kit
o Endurance Test	o Operators Deployment Test
o Air Flow Test	o Smoke Tracer Test
o Operator Deployment Test	

PRODUCTION COST ESTIMATE

Estimates of production costs for the Pedal Ventilator Kit (PVK) and Kearny Pump Kit (KPK) were made based upon procurement quantities of 10,000 units each. The estimates made update those made in 1970 and include not only inflation realized since then, but also the reduction in costs due to improvements made as a result of this program. GARD's Technical Products group assisted the engineering department with estimates of purchased parts, materials and services. Their computerized "Bill of Material" and "Summarized Material Requirements" programs were utilized to tabulate, extend and

totalize these estimates for each kit. GARD's Technical Products group is involved in the production and light manufacture of new products developed by GARD's Engineering group.

CONCLUSIONS

Based on the data obtained for the PVK and KPK during the testing phase of the subject program, GARD feels confident the units can easily endure operational service for a period of one month. The deployment tests for both kits indicated no people/equipment problems in effectively deploying the kits into operation. The redeeming feature of the pedal ventilator, in particular, is its similarity to the common bicycle. All participants immediately performed the proper operation of the unit with no written or oral instructions. The Kearny pump required a short period (approximately 30 second average) of time for the operator to obtain the proper natural frequency required for effective cooling. However, the cost of the unit for the delivered CFM make the PVK a viable candidate for shelter implementation.

The production cost estimates for the kits involved two distinct cost estimates for each unit to effectively formulate the cost reduction realized by the present program. Since the kits had not been estimated since 1970, GARD updated the production costs to 1979 levels by evaluating inflationary and labor factors during the previous seven years. The formulation of these costs included vendor and suppliers' quotes wherever possible. GARD then recosted the units based on the revisions implemented in the engineering study. The results of the 1979 cost comparison indicate a reduction of 12% for the PVK and 8% for the KPK.

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The objective of this program was to evaluate two types of ventilator kits for maximum cost effectiveness. The kits evaluated were the pedal ventilator and the Kearny pump. Both kits are designed to provide ventilation of designated fallout shelters. The subject units were previously developed by GARD, INC. in 1969 for DCPA under Contract No. DAHC20-68-C-0123.

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ABSTRACT (Cont'd)

An engineering study was conducted on the ventilator kits to determine the potential manufacturing economies. Based on the conclusions of the study, the fabrication drawings, military specifications and deployment instructions were updated to reflect modifications determined to be cost-effective.

Three prototype units of each kit were fabricated and assembled utilizing the revised documentation. One set of the ventilator kits was subsequently tested to assure that the units' performance and reliability were not compromised.

Production cost estimates based on a procurement of 10,000 units each were generated for DCPA budgetary purposes.

FOREWORD

This final report was prepared by GARD, INC., Niles, Illinois for the Defense Civil Preparedness Agency under Contract No. DCPA01-78-C-0184. The effort under this program was monitored by Mr. Donald Bettge of DCPA Research.

The report covers the work performed on the contract during the period of 27 March 1978 to 31 March 1979 and describes the engineering study, fabrication and testing of two types of ventilators for use in Civil Defense shelters.

The authors wish to thank Mr. S. F. Fields, Mr. R. Patel, and Dr. L. B. Holmes of GARD for assisting in the formulation of air flow tests; and Mr. Gunther Dorth, Director of Technical Products, for his intensive effort in generating the computerized cost estimates presented in this report. Thanks are also due to Mr. Bettge for his valuable assistance during the course of the subject program.

Reviewed by

R. J. Klima
Program Manager

L. B. Holmes, Ph.D., Manager
Mechanical Systems Department

Approved by:

P. A. Saigh
Director, Contract Programs

ABSTRACT

The objective of this program was to evaluate two types of ventilator kits for maximum cost effectiveness. The kits shown on the following page are: (1) Pedal Ventilator Kit, and (2) the Kearny Pump Kit. The two units were previously developed by GARD in 1969 for DCPA under Contract No. DAHC20-68-C-0123.

An engineering study was conducted on the ventilator kits to determine the potential manufacturing economies. Based on the conclusions of the study, the fabrication drawings, military specifications and deployment instructions were updated to reflect modifications determined to be cost-effective.

Three prototype units of each kit were fabricated and assembled utilizing the revised documentation. One set of the ventilator kits was subsequently tested to assure that the units' performance and reliability were not compromised.

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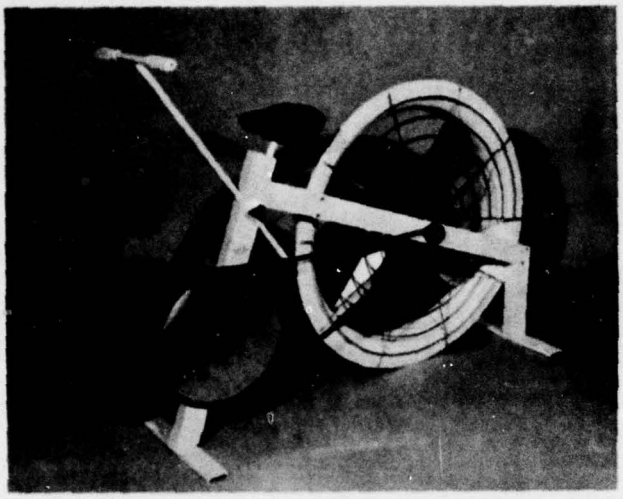
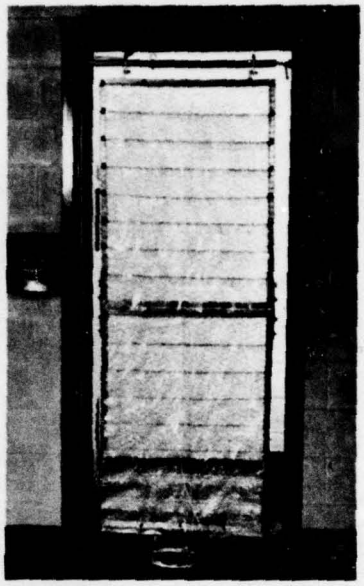


(1) Pedal Ventilator Kit (PVK)



(2) Kearny Pump Kit (KPK)
with Doorway Support Bar

TWO TYPES OF VENTILATOR KITS

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Section 1

BACKGROUND

The need for portable shelter ventilation equipment was specified by an Office of Civil Defense Task Group formed in 1963 to study the feasibility of various modes of ventilation and deployment.[1]* The design and development of the MIL-V-40645 modular package ventilation kit resulted from the recommendations of this task group.[2] The kit employed a 20-inch diameter propeller fan that could be electrically powered.

Subsequent shelter equipment evaluations conducted by GARD showed that this ventilator as designed could not readily be employed by untrained persons. Also, a cost optimization study, limited to fans with diameters of 36 inches or less, revealed that a shelter ventilation system of minimum cost would require three units with 36-inch diameter fans rather than 20-inch diameter fans.[3]

These units would be a one-operator pedal-driven unit, a four-operator pedal-driven unit, and a 5-HP electric motor-powered unit.[4] This program was conducted by GARD, INC. under subcontract to Stanford Research Institute.

The study was limited to fans with diameters of 36 inches or less, since it was assumed the minimum width of shelter doorways was 36 inches. A later study disclosed that the minimum width of doorways in commercial/institutional buildings is 31 inches. To avoid excessive pressure losses in ducts caused by restrictions at the doorways, it was decided, with OCD approval, to develop pre-assembled one and two-operator bicycle ventilator kits utilizing a fan and ducting system of 30 inches in diameter.

This requirement directly led to the development of the subject One-Operator Pedal Ventilator (Drawing No. 1477J6000) and associated specifications.

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* Superscripts refer to Section 6, References.

Simultaneously, GARD was developing the Ventilator Kit, Flap Air Pump (Kearny type (KPK)) and specifications thereof. The Kearny pump was designed to be employed both as a doorway ventilator (Drawing No. 1477E3000) suspended from a doorway support bar (Drawing No. 1477D2000), and as a "stand alone" ventilator utilizing an A-frame support assembly (Drawing No. 1477J2000). This effort was accomplished under Contract DAHC20-68-C-0123 by GARD for the OCD.[5]

The effort described above was concluded and summarized in GARD Final Report No. 1477-1 dated January, 1971. Renewed procurement interest by Defense Civil Preparedness Agency (DCPA; formerly OCD) in early 1978 prompted the initiation of the subject program to update the previous ventilator kits. The object of the program was to reduce fabrication and hardware cost wherever possible without detracting from the performance, durability and deployment of the kits.

Section 2

PEDAL VENTILATOR KIT (PVK)

The pedal ventilator kit (DCPA Dwg. No. 1477J6000), shown in Figures 2-1 and 2-2, utilizes a 4-bladed, 30 inch diameter fan powered by a sprocket/roller chain transmission ratio of 7.70:1. An average operator would apply a 0.1 HP input, at a crank speed of approximately 55 RPM, with a resultant fan velocity of 423 RPM. The unit incorporates a bellmouth shaped shroud for maximum flow efficiency. A principal feature of this ventilator is that the unit is fully assembled when packaged to eliminate in-shelter assembly.

2.1 Engineering Study - Pedal Ventilator Kit

The objective of the engineering study was to conduct a review of the various PVK components to determine the areas of potential cost reduction. The study was formulated using the following criteria as guidelines.

(A) Utilize "off the shelf" hardware wherever possible.

(B) Eliminate unnecessary machining operations.

(C) Delete non-functional parts.

(D) Facilitate assembly.

No revisions were considered that would detract from the performance, durability, or deployment of the kit. Since the pedal crank, crank bearing parts, pedals, fan and saddle were commercially available components, they were investigated for source cost comparison only.

The goal for the engineering study was to reduce the kit unit cost (after inflation) by 10 to 15% from the 1970 configuration.

The specific findings of the engineering study for the pedal ventilator kit are described in the following subsections. The location of the revision

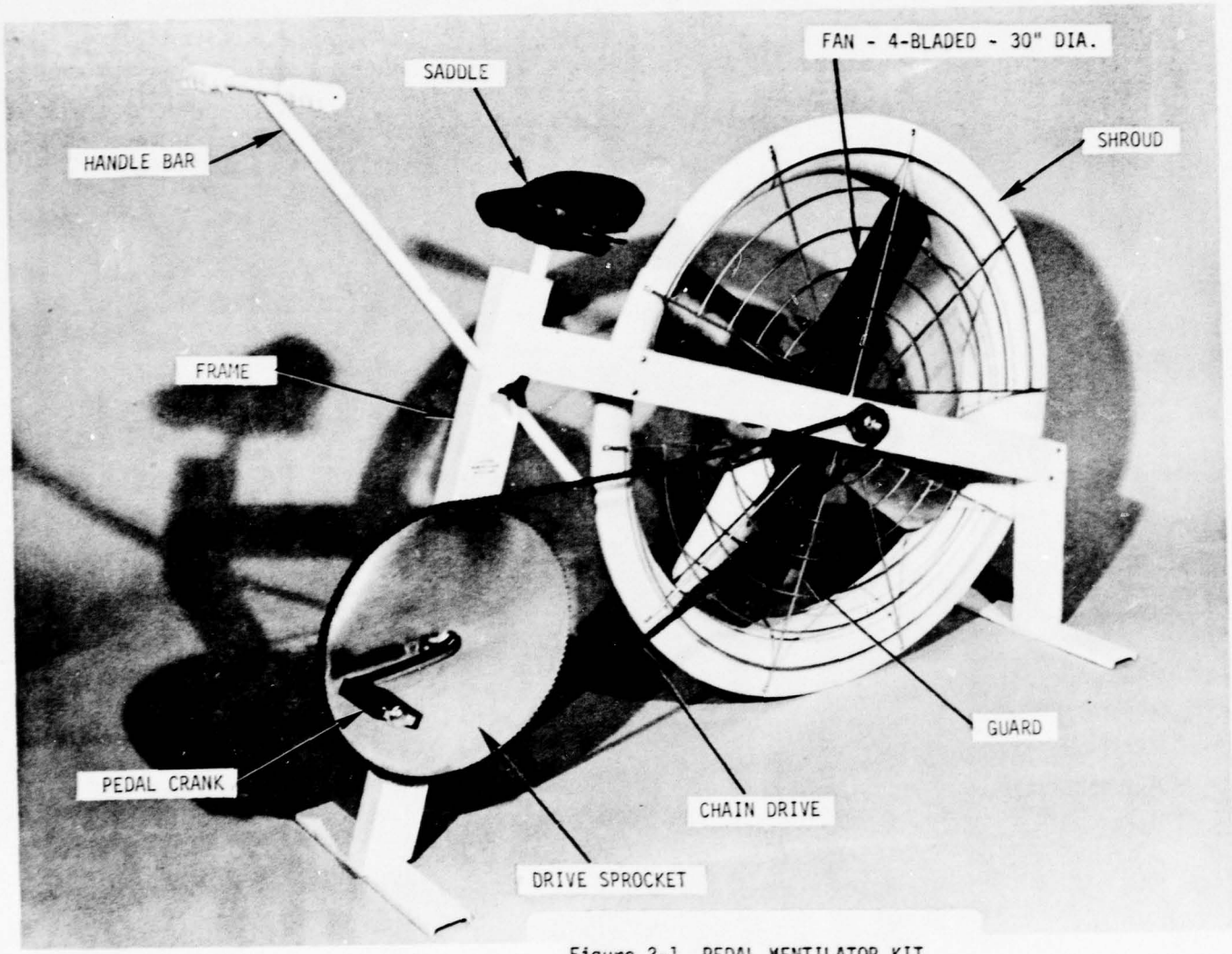


Figure 2-1 PEDAL VENTILATOR KIT

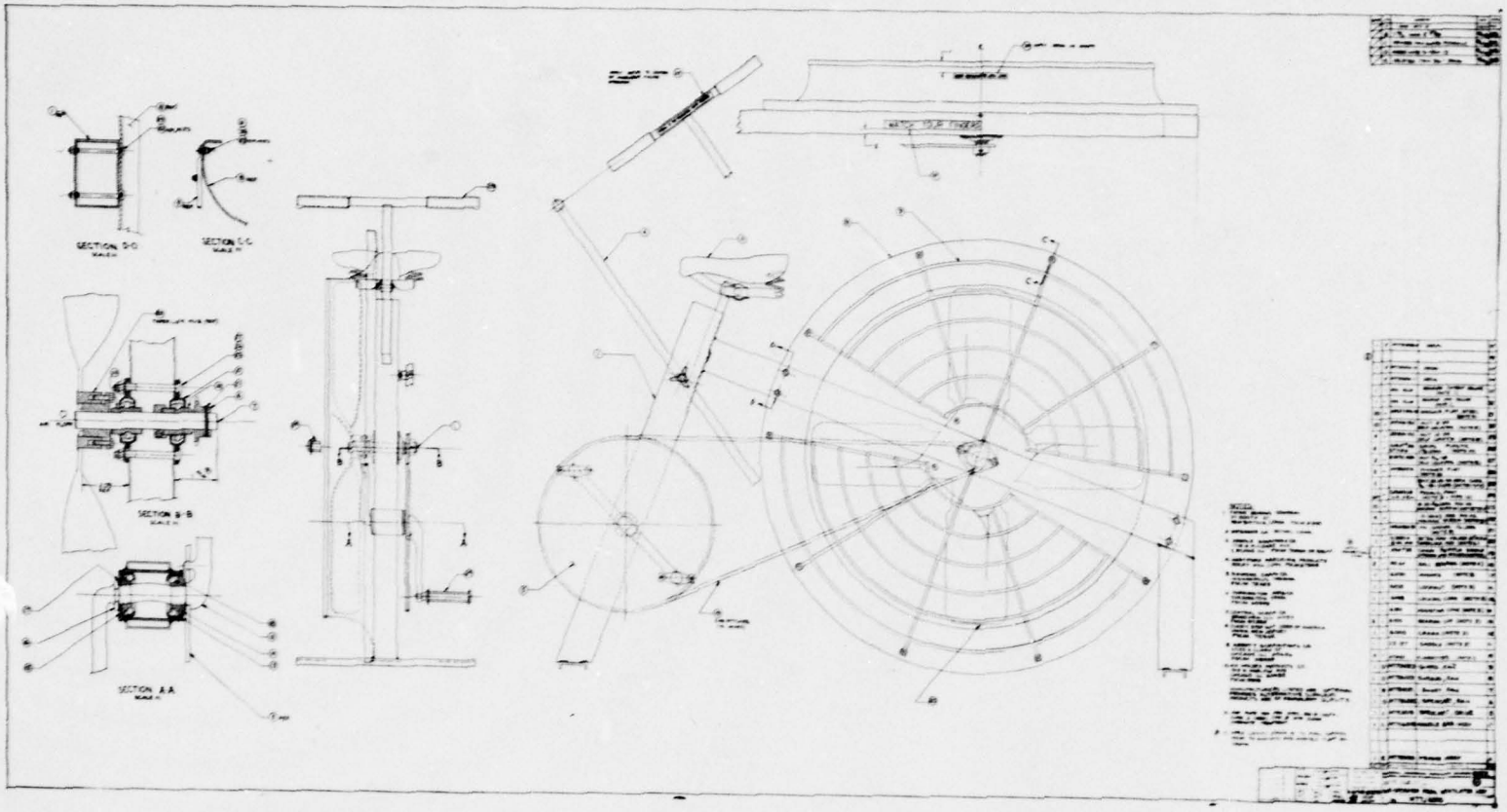


Figure 2-2 PEDAL VENTILATOR KIT

areas discussed are defined by the corresponding paragraph number on Figure 2-3.

2.1.1 Screw, Locking Hand - Dwg. No. 1477A6016

The function of the part is to provide the locking feature for adjustment of the handle bar assembly. The part, as depicted on the drawing, involved forming, threading and plating operations. A suitable commercial replacement was chosen. The part is a fluted plastic knob with a plated steel stud pressed into the handle. It is manufactured by the H. Davies Molding Co., Chicago, Illinois.

The 19¢ unit cost for this part represents a savings of 26¢ from the previous fabricated locking screw.

2.1.2 Hanger, Crank - Dwg. No. 1477B6015

The function of the hanger is to provide the housing for the commercial crank bearing assembly. The part as depicted on the previous drawing shows three formed dimples located 120° apart on each end of the hanger. The dimples served to provide an interference fit with the crank bearing outer race cone. Discussions with Arnold Schwinn manufacturing engineers indicated the dimpling process is no longer required and has been eliminated. GARD modified the drawing accordingly, which simplified the fabrication process.

The projected savings from this revision is estimated to be 30¢ per part.

2.1.3 Sprocket, Drive - Dwg. No. 1477C6019

The drive sprocket is a large (131 teeth) steel sprocket which is driven through the pedal crank by the operator. The cost of the part is relatively high because it is a "special"; 96 teeth is the largest diameter normally stocked by chain and sprocket manufacturers. Utilizing the 96 tooth sprocket, the drive train ratio would be reduced by approximately 27%. At the optimum pedal speed of 55 RPM, the fan velocity would be reduced from the present

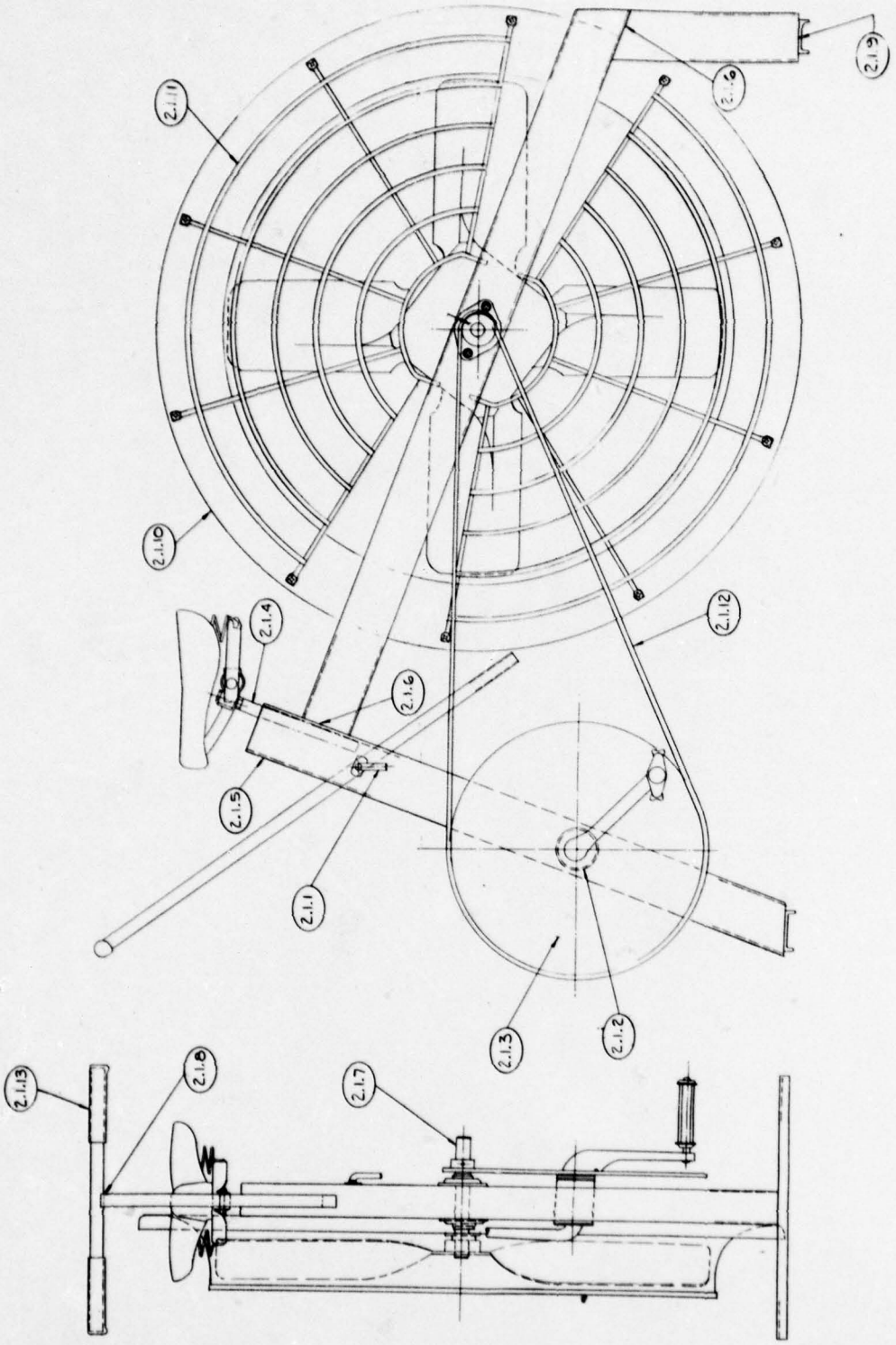


Figure 2-3

423 RPM to 308 RPM. Since the fan speed range recommended for maximum ventilation effectiveness is 400[5] to 500 RPM, the 96 tooth sprocket was not considered as a suitable replacement. Plastic molded sprockets were investigated for cost-effectiveness. The plastic sprockets were found to be only competitive in quantities of 100,000 or greater due to the initial tooling costs.

GARD chose to retain the steel sprocket for the production model. Estimated unit cost for this part in quantities of 10,000 is 11.71¢ each.

2.1.4 Stem, Saddle - Dwg. No. 1477B6017

The function of the stem is to provide the mounting and support for the operator's saddle. The part as depicted on the unrevised drawing was fabricated from .75 inch square steel bar with the far end turned to a .87 inch diameter to accept the mounting of the operator's saddle.

GARD changed the material to .87 inch diameter round mechanical tubing with a 1.25 inch wall thickness. The revision eliminated one machining operation (lathe) and reduced the raw material cost of the part. An estimated saving of 20¢ per part is projected as the result of the modifications.

2.1.5 Leg, Front Support - Dwg. No. 1477C6011

GARD investigated the re-arrangement of the support frame by shortening the front support leg to allow the bar, fan support to sit on the top side of the leg. This would provide a less costly structural tie. However, this configuration presented problems in accommodating the square clearance holes necessary to receive the handle bar assembly. GARD retained the original frame configuration as it became apparent that the cost trade-off was insignificant.

2.1.6 Frame Assembly - Dwg. No. 1477E6010

The frame assembly represents approximately one-third of the cost of the assembled ventilator before accessories, ducting, and packaging costs are implemented. Therefore, the frame was carefully scrutinized for potential cost savings. The 1969 frame design included continuous welds at all structural frame member junctions. A stress analysis was performed on the frame to determine how much welding, if any, could be eliminated without jeopardizing the structural integrity of the frame when subjected to a 300 lb. compression load. Since the 1/8" fillet weld, which is utilized on most frame junctions, is rated at 1100[6] lbs. tensile and 770 lbs. shear per running linear inch of weld, it became apparent that the continuous weld previously specified was extremely conservative. GARD reduced the total welding by 30%, which is still conservative for normal operating loads, but makes the frame less susceptible to severe impact load during shipment of the kit.

The revised welding specifications are estimated to save $8.33 per unit from the previous frame configuration.

2.1.7 Shaft, Fan - Dwg. No. 1477B6021

The original length of the fan shaft extended 1-5/8" beyond the fan hub. The purpose of the extension was to provide additional shaft for mounting a pulley that was driven by a motor kit previously specified. The shaft end included a milled flat to secure the pulley. Since the motor kit is no longer included in the present package, GARD shortened the shaft by 1-5/8" and deleted the milling operation. It is estimated the above revision will result in a cost saving of 15¢ per unit.

2.1.8 Handle Bar Assembly -Dwg. No. 1477C6018

The handle bar assembly consists of a .75 inch square tubing member welded perpendicular to a .75 inch diameter tube. The radius milled into the square tubing to nestle the handle bar was considered costly. GARD revised the design to utilize a notch rather than the radial cutout. The end machining would be performed with a notching die in a normal production run. In addition, the welding required was reduced by 50%. A cost reduction of approximately 45¢ per assembly can be realized by the revisions incorporated.

2.1.9 Foot, Rear Support - Dwg. No. 1477B6025

The rear support foot was identical to the front support foot with the exception of two holes provided for the mounting of the electric motor drive kit. Since the motor drive kit is no longer required, the drawing (1477B6025) was voided and the front foot quantity required was changed to two. The commonality of parts and reduction of two holes is estimated to save 30¢ on this unit.

2.1.10 Shroud, Fan - Dwg. No. 1477D6022

The previous fan shroud was fabricated from .08 inch thick 5052-0 aluminum material. After consulting with several spinning type fabricators in the Chicago area, it became apparent that a substantial savings could be realized by a material change. The shroud can be spun using 20 GA. (.035) 1018 steel in place of the aluminum. The raw material savings alone amounts to $5.17 each unit. In addition, the return flange on the input side of the shroud was shortened from .87 inch long to .37 inch long. The basic shape of the shroud (bellmouth orifice) was not revised, since it causes the smallest static pressure loss, and thus, for a given power input, the largest flow.

It was felt that the shroud could have been 'dished' or deep drawn using a hydraulic press-operated die, but the quantities required were 100,000 units or more. A molded plastic shroud would also be competitive with a larger procurement.

The revised material specification and configuration is estimated to result in a cost reduction of $7.50 per unit.

2.1.11 Guard, Fan - Dwg. No. 1477D6023

The function of the guard is to prevent loose clothing being drawn into the fan mouth during operation of the ventilator. It also assists in restricting the accidental entry of hands and feet of the shelter occupants.

The guard is fabricated from formed steel wire (.192 inch dia.) and spot-welded construction. Each pedal ventilator required two identical guard assemblies each mounted on opposing sides of the fan support bar. The previous guard configuration had two extending rods which nested in matching holes located in the ventilator frame. GARD deleted the two rod locators and extended the center spoke of the guard to provide the mid-support point at the frame. The revision eliminated two forming operations on each guard (4 per PVK) and two matching holes on the frame. The savings realized for each pair of guards is approximately 42¢.

2.1.12 Roller Chain, Drive - ASA #35 - 3/8" Pitch

The roller chain provides the power transmission between the drive sprocket and the fan sprocket. Information regarding a plastic chain manufactured by the Plastock Corporation was solicited early in the engineering study. The plastic chain offers a distinct advantage: long shelf life without lubrication.

The chain is fabricated from Nylatron (GS) material and the average tensile strength in the 3/8" pitch size is 140/121 pounds compared to 1800 pounds for the steel chain. GARD feels the 140/121 pound tensile strength is marginal for the ventilator application, and simulated endurance tests should be conducted before specifying the plastic chain on production ventilator kits.

Surprisingly, the plastic chain was found to be more expensive than steel in both small and large quantities. Comparative price quotes based on quantities of 100,000 feet each are shown below.

Type Chain	Cost/Foot	Cost/Ventilator
Steel (domestic)	$ .70	$ 5.42
Steel (Japan)	.54	4.18
Plastic (Nylatron)	.75	5.81

The cost comparison in small quantities (50 ft. or less) is even more dramatic. Steel chain is $1.78/ft. vs. $2.82/ft. for plastic. GARD ordered 10 feet of plastic chain for evaluation purposes.

A 'V' belt drive was considered as a replacement for the present roller chain. Since the pedal drive and fan shaft location are fixed, it would require using a somewhat larger belt for installation and taking up the slack with an adjustable idler pulley. The additional cost of the idler pulley assembly negates any savings realized by using the 'V' belt drive.

In addition, the efficiency of 'V' belt drives (88%) is less than roller chain (98%) due to losses incurred by creeping, stretch and belt aging.

Based on the above study, GARD chose to retain the #35 roller chain (steel) for the production ventilator.

2.1.13 Handle Grips - Dwg. No. 1477E6000

The plastic grips incorporated on the present and previous pedal ventilator are more aesthetic than functional, particularly in a static operational mode. From a human engineering standpoint, however, they readily relate the operator to the function of both the handle and the PVK itself. GARD proposed to eliminate the grips and replace them with plastic caps pressed into each end of the handle bar tube. However, the large quantity unit cost of vinyl dip-molded grips (.06¢ each) was considered low enough to substantiate retaining them in the production unit.

2.2 Revision of PVK Drawings, Specifications and Instructions

Based on data compiled in the completed engineering study, GARD incorporated all valid cost-effective revisions to the applicable drawings on the pedal ventilator kit. The Military Specifications and operating instructions were updated to reflect any additions or deletions deemed necessary by the changes in the PVK design configuration.

2.2.1 Pedal Ventilator Kit - Drawings

The approriate revisions were made to the original vellums of the PVK drawing package. The revisions were properly recorded on the field of the drawing and the revision block located in the upper right-hand corner of the drawing. The drawings were then checked prior to release for fabrication of the prototype kits.

Reproducible sepias were made of the subject drawings prior to any revisions to provide any future reference to the previous configuration. GARD will retain these sepias, which are available upon request.

2.2.2 Pedal Ventilator Kit - Military Specifications

The Military Specification for the pedal ventilator kit was updated to reflect the current revision status of all applicable Federal and Military Specifications and Standards. The drawing list was aslo revised to indicate any deletions and additions allocated to the engineering study. Quality assurance provisions were checked for conformance to the present PVK configuration. The

revised Military Specifications are shown in Appendix A of this report.

2.2.3 Pedal Ventilator Kit - Operating Instructions

The PVK operating instructions were reviewed for any revisions deemed necessary. The actual changes were minor, with a new PVK photograph added and references to the pedal ventilator motor deleted. The revised operating instructions are included in Appendix B of this report. The final submission of the instructions are original camera copy.

2.3 Documentation Review - Pedal Ventilator Kit

Prior to fabrication of the pedal ventilator prototypes, a documentation review meeting was held between DCPA and GARD technical representatives to assure compliance with the revised documentation. All drawing changes and the revised Military Specifications for the PVK were reviewed and discussed. All changes noted as a result of the meeting were incorporated before the start of fabrication.

2.4 Fabrication - Pedal Ventilator Kits

Utilizing the updated drawing package, three pedal ventilator kits were fabricated and assembled. Any discrepancies noted during the construction of the units were noted and corrected on the original vellums of the drawing package.

The fabricated PVKs included the following deliverables:

Quantity	Description
3 each	Ventilator Kit, Pedal-Operated, as per DCPA Drawing No. 1477J6000
3 each	Duct, polyethylene, one roll, 30-inch diameter x 50 feet long x 4 mil thick
3 each	Tape, duct, pressure sensitive, one roll, 2 inches wide x 30 yards long.

Operator Pedal Ventilator (Drawing No. 1477J6000) and associated specifications.

* Superscripts refer to Section 6, References.

Upon completion of the above kits, GARD shipped one kit to DCPA Research and one kit to the Defense Logistics Agency for display and inspection purposes. GARD retained one pedal ventilator kit for testing purposes.

2.5 Testing - Pedal Ventilator Kit

Extensive testing of the pedal ventilator was performed under Contract No. DAHC20-68-C-0123 for the DCPA. These tests included measuring air flow rate, fan performance, blast tests, endurance tests and human engineering studies. The test procedures, results and performance data are compiled in the GARD Final Report No. 1477-1, "Shelter Ventilation Studies" under the above contract number.

Since the results of the engineering study did not affect the fan, shroud or power transmission of the unit, it appeared to GARD that a duplication of the above tests would not be cost-effective. Therefore, GARD performed the tests described in the following subsections to assure that the overall functional performance of the unit had not been violated.

2.5.1 Endurance Test - PVK

An endurance test was performed with the pedal ventilator kit to determine the integrity of its components during long term operation. The test setup shown in Figure 2-4 utilizes a motor driven pair of articulated arms which mechanically simulate the human input. The operator's saddle was removed to accommodate the mounting of the drive unit. The pedal crank was driven continuously at 60 RPM by the mechanism for 8 hours daily for a total of 20 days.

The testing commenced on 4 January 1979 and was terminated on 31 January, 1979. Observations at the end of each testing day were noted in a testing log. During the total 160 hours of testing, no component failure or deterioration occurred on the pedal ventilator.

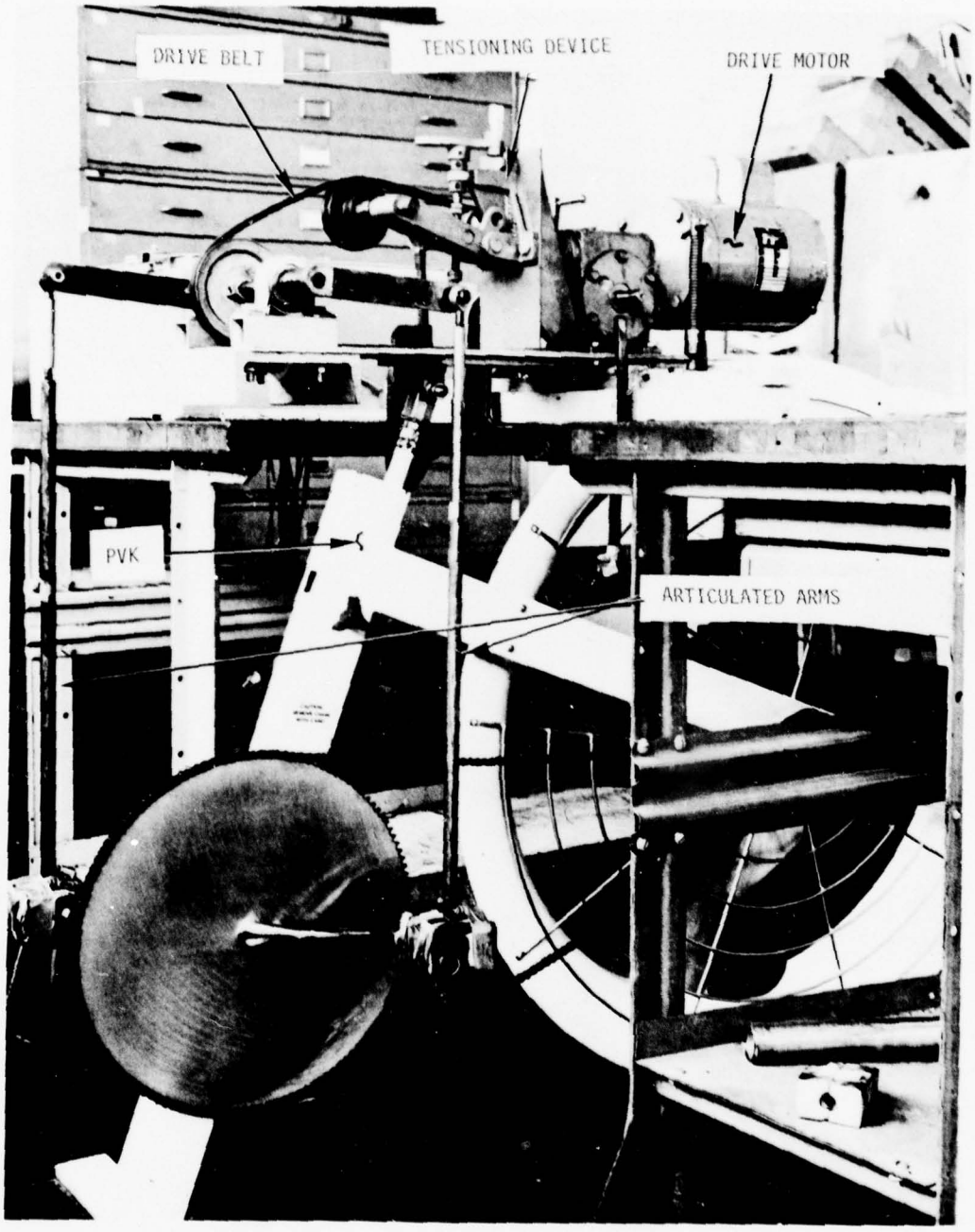


Figure 2-4 ENDURANCE TEST SETUP - PVK

kit are described in the following subsections. The location of the revision

The test fixture required various adjustments during the test period. The only significant observation noted was the roller chain drive appeared to develop more slack when the unit was in operation for greater than six continuous hours (observable in Figure 2-7). This is due to the thermal expansion of the links under sustained rapid operation. It was not considered detrimental to the ventilator's operational reliability.

2.5.2 Air Flow Test - PVK

As previously stated, GARD performed extensive air flow measurements of the pedal ventilator under past DCPA programs.[5] The unit was tested by the Air Moving and Conditioning Association, Inc. A constant speed test curve of horsepower vs. flow was generated for the entire range from zero static pressure (free air) to zero flow. This data was converted to static pressure vs. air flow curves for a constant input of .10 horsepower. Since the principal elements of the PVK relating to air flow were not altered, a repeat of the above tests were not considered necessary or appropriate.

The following limited air flow test procedures were performed under the current program.

2.5.2.1 Air Flow Test Design - PVK

GARD contemplated several air flow test configurations before choosing the primary design utilized. One of the test configurations considered is shown in Figure 2-5. The purpose of this arrangement was to measure the mean velocity of air discharged from the ventilator through a circular duct. The air would flow from the ventilator through the circular duct, through a transition section and through a discharge plate to the atmosphere. The discharge plate would have several holes bored for the air to flow. The combined area of the air passage holes would equal the cross-sectional area of the duct.

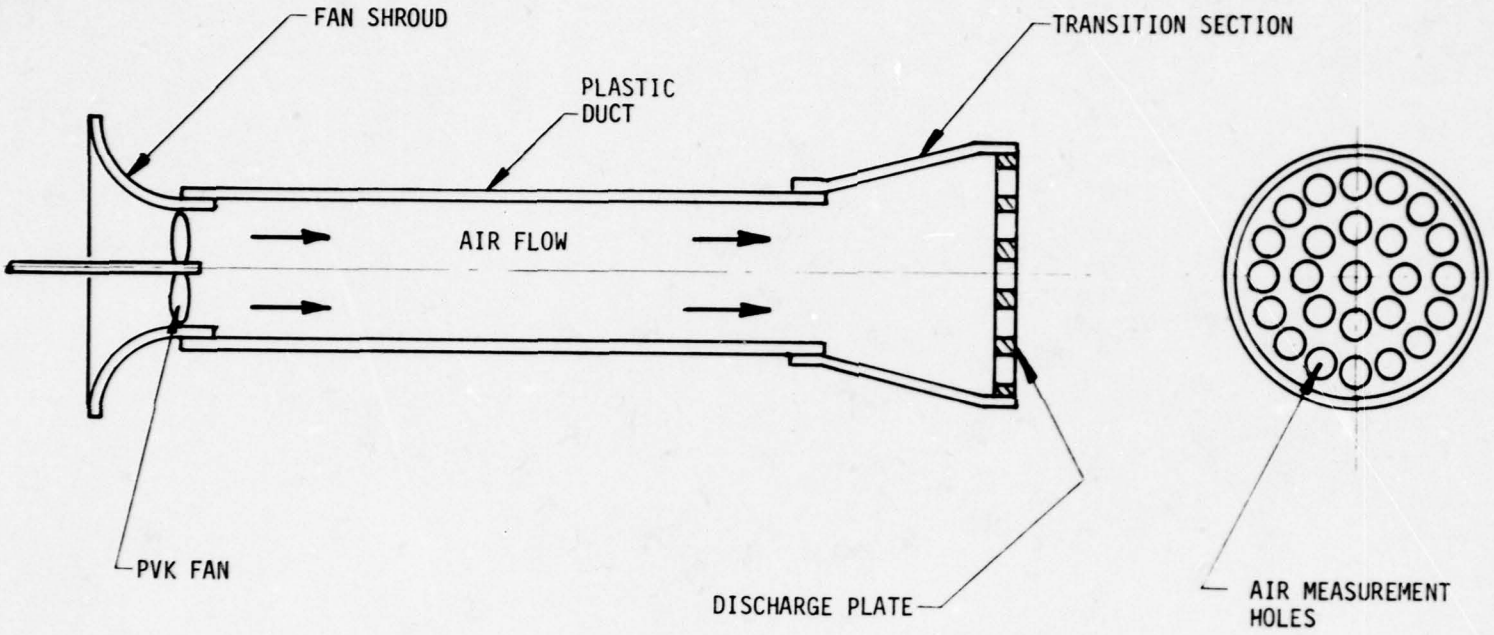


Figure 2.5 CONSIDERED PVK AIR FLOW TEST CONFIGURATION

Each hole would be of sufficient diameter to facilitate installation of a vane-type anemometer to measure the velocity of air flow through the hole.

However, no air flow test was carried out in the above proposed setup because the duct kept collapsing and because a simpler arrangement was devised.

2.5.2.2 Air Flow Test - PVK

The simpler design configuration chosen for the air flow test is as shown in Figure 2-6. The air discharged from the ventilator flowed through a 30-inch diameter circular metal duct, 12 feet long, to the atmosphere. The photograph of the actual air flow test setup is shown in Figure 2-7.

The duct was secured to the fan shroud with ducting tape. Eight small holes were drilled on the duct in a section 1-1/2 feet from the discharge end. These holes were spaced 45° apart and would accept the bracket holding an anemometer for reading the air velocity at various points in the duct's cross-section (see Figure 2-8).

The pedal crank of the ventilator was driven at 60 RPM by an electric motor and air velocity measurements were taken at various points shown in Figure 2-9. These readings are tabulated in Figure 2-10. Average air velocities at 5" radius and 10" radius from the centerline of the duct are plotted in Figure 2-11.

Air-velocity-to-duct radius relationship indicates that the flow is a swirling flow. Extrapolating the graph beyond the 10" radius would give a relationship as shown by the dotted line, with air velocity dropping off sharply towards the wall of the duct and approaching zero at 15" radius.

pedal speed of 55 RPM, the fan velocity would be reduced from the present

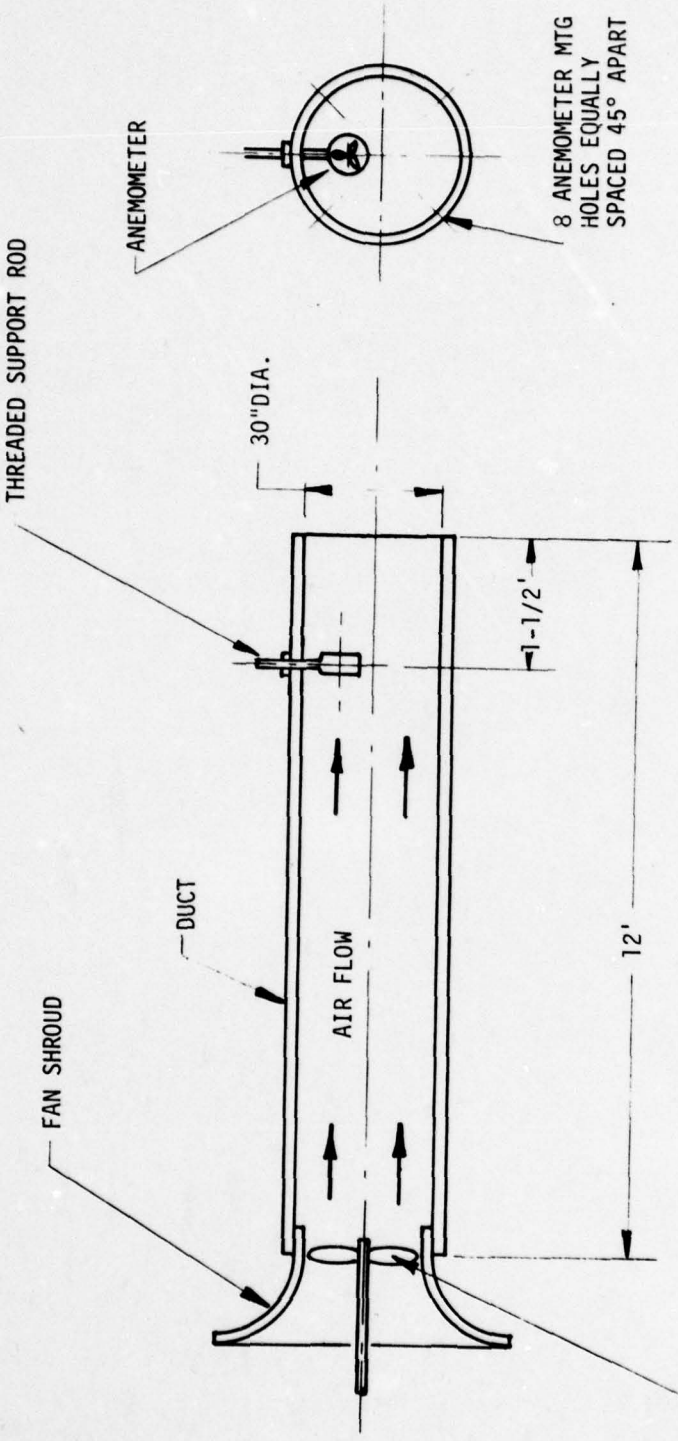


Figure 2.6 CHOSEN PVK AIR FLOW TEST CONFIGURATION

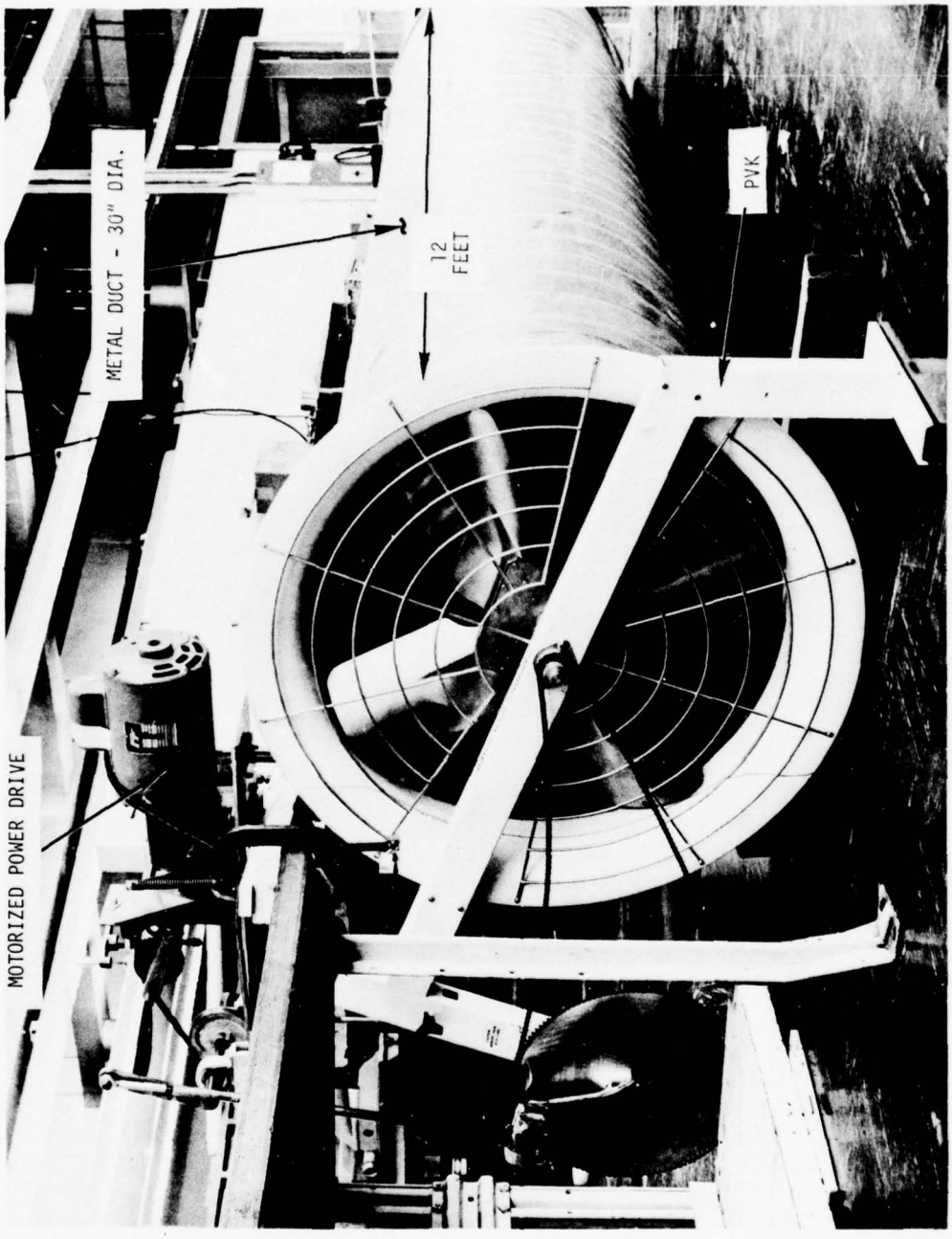


Figure 2-7 AIR FLOW TEST SETUP - PVK

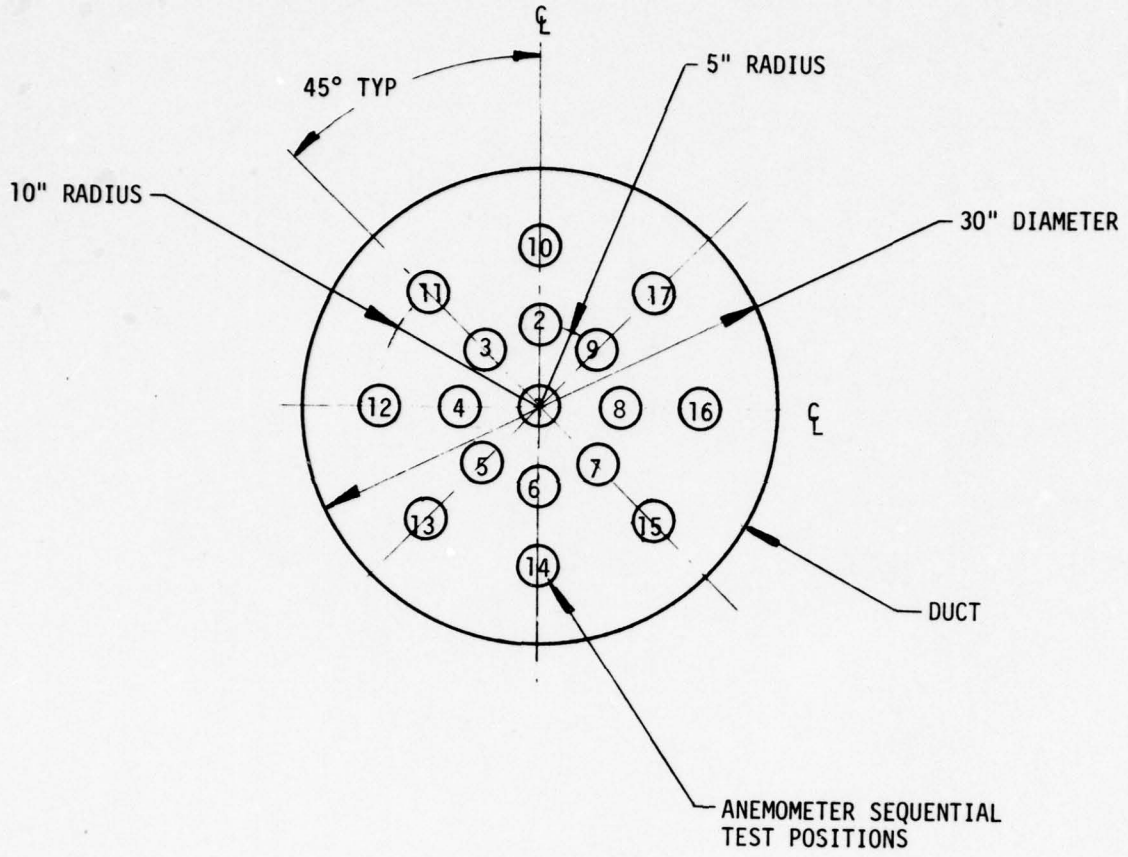


Figure 2-9 DUCT CROSS SECTION
PVK AIR FLOW TEST

AIR FLOW MEASUREMENTS - PVK

Anemometer Location	Anemometer Reading - At end of two minutes ft/2 min.			Air Velocity ft/min.	Avg. Air Velocity	
	Set I	Set II	Avg.		ft/min.	in./sec.
1	1450	1501	1476	738	738	147.6
2	1532	1560	1546	773		
3	1576	1558	1567	784		
4	1666	1671	1668	834		
5	1833	1846	1840	920	851.75	170.35
6	1880	1868	1874	937		
7	1760	1774	1767	884		
8	1660	1677	1668	834		
9	1588	1603	1696	848		
10	1815	1823	1819	910		
11	1760	1786	1872	936		
12	1810	1794	1802	901		
13	1957	1950	1954	977	936.38	187.28
14	1948	1954	1951	976		
15	1900	1900	1900	950		
16	1836	1814	1825	913		
17	1856	1857	1856	928		

Figure 2-10 AIR FLOW MEASUREMENTS - PVK

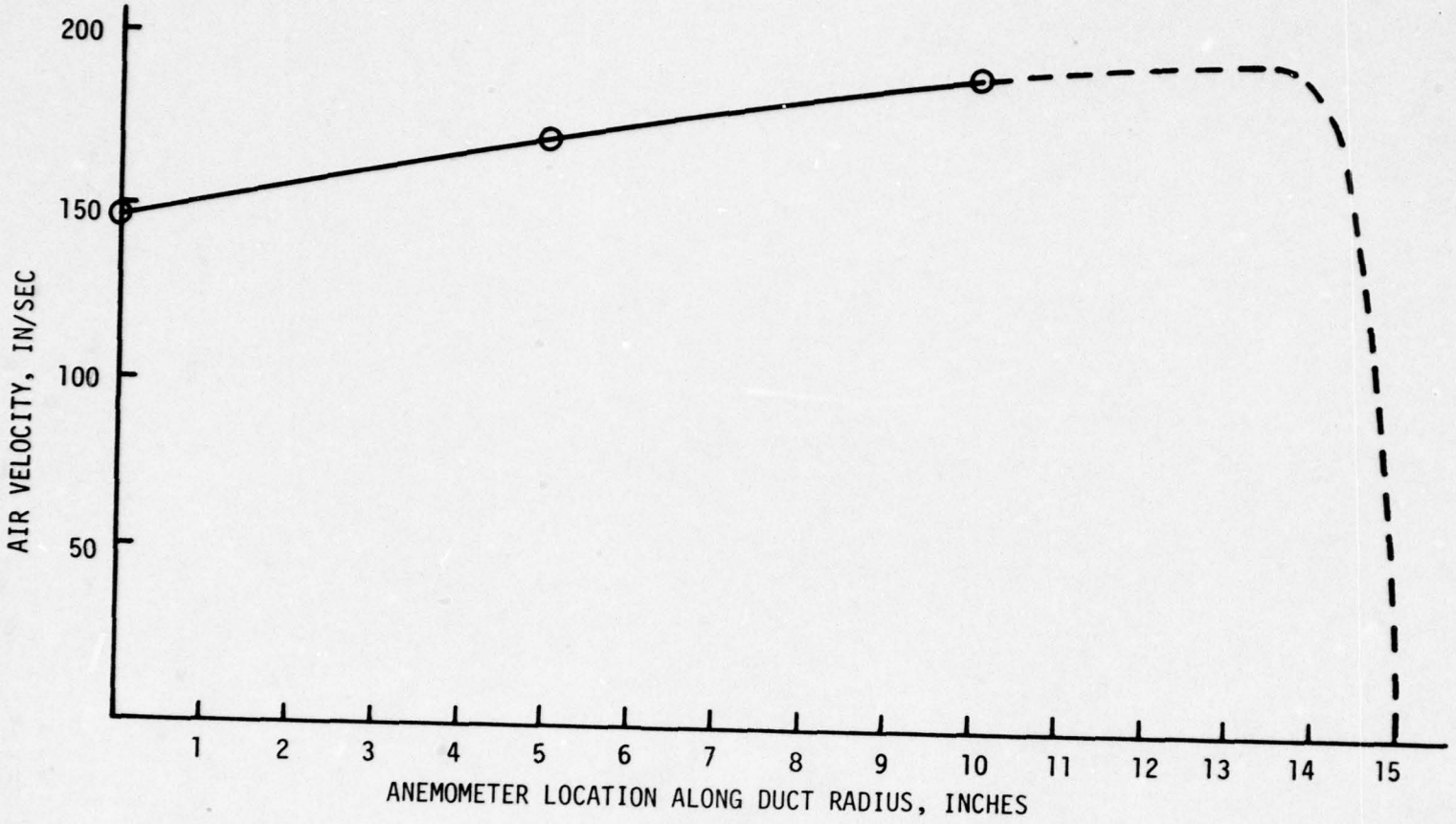


Figure 2-11 AVERAGE AIR VELOCITIES
PVK AIR FLOW TEST

Sections of the graph from 0-5" radius and from 5" to 10" radius can be considered linear. It can further be hypothesized that the average velocity of air flow through the duct would be the average velocity of air flow up to 10" radius.

Average air velocity through the duct is equal to the average of the 0-5" area times the average air velocity in that region plus the 5"-10" annular area times the air velocity in that region, respectively, or

$$\frac{1}{\pi \times 10^2} \left[\pi \times 5^2\left(\frac{147.60 + 170.38}{2}\right) + \pi(10^2 - 5^2)\left(\frac{170.38 + 187.28}{2}\right)\right]$$

$$= 173.87 \text{ in/sec.}$$

Air flow through the duct is therefore

$$173.87 \times \pi \times 15^2 = 122{,}951 \text{ cu in/sec.}$$

$$= 4209 \text{ cfm.}$$

The resultant 4209 cfm air flow compares favorably (within 5%) of previous air flow data generated for the DCPA.

2.5.3 Operator Deployment Tests - PVK

The final series of tests performed on the PVK involved the operation of the unit by a number of volunteers within GARD's business operations staff. The volunteers were solicited through an interoffice memo and represented male and female participants unfamiliar with the pedal ventilator kit.

A 40-foot long polyethylene duct of 30-inch diameter was attached to the fan shroud simulating actual shelter operational conditions. The 8-hour test was conducted in two morning sessions on 1 March and 2 March, 1979, as indicated in the test schedule shown in Figure 2-12.

GARD, INC.

TO Distribution DATE 27 Feb. 1979

FROM J. M. Buday JMB

SUBJECT PEDAL VENTILATOR TEST
(Two morning sessions on 1 March and 2 March, 1979)

8:00	- 8:15	(1)	G. Zima
8:15	- 8:30	(2)	J. McGreevy
8:30	- 8:45	(3)	A. Horneck
8:45	- 9:00	(4)	W. Graycyzk
9:00	- 9:15	(5)	M. Zeszutko
9:15	- 9:30	(6)	G. Sullivan
9:30	- 9:45	(7)	M. Potts
9:45	- 10:00	(8)	S. Chrapkowski
10:00	- 10:15	(1)	G. Zima
10:15	- 10:30	(2)	J. McGreevy
10:30	- 10:45	(3)	A. Horneck
10:45	- 11:00	(4)	W. Graycyzk
11:00	- 11:15	(5)	M. Zeszutko
11:15	- 11:30	(6)	G. Sullivan
11:30	- 11:45	(7)	M. Potts
11:45	- 12:00	(8)	S. Chrapkowski

NOTE: Please contact me if the time allotments conflict with your schedule. Wear appropriate clothing for test.

OPERATING INSTRUCTIONS:

The recommended operational speed is one revolution of the pedal crank per second (60 RPM), but operators should pedal at any speed that is comfortable for the 15 minute duration.

JMB:hr

Figure 2-12 PVK TEST SCHEDULE

A pedal crank speed of approximately 60 RPM was recommended to the operators for the 15 minute test run. All of the participants maintained this cycle rate during the testing. Photos taken during the performance of the operation test are shown in Figure 2-13. Typical of the comments the operators offered are the following.

- o Easy to pedal because of large sprocket ratio.
- o Should have coaster mode similar to a conventional bicycle.
- o Very easy operation.
- o Runs steady and comfortable.
- o Saddle too hard and uncomfortable.
- o 15 minutes should be maximum. Legs got fatigued.

No mechanical failure or wear of the pedal ventilator was observed during the test. None of the eight participants adjusted the handle bar height from its pre-test position. It is apparent from the test that the redeeming feature of the pedal ventilator is its similarity to the common bicycle. All participants immediately performed the proper operation of the unit with no written or oral instructions.

(A)

(B)

(C)

(D)

(E)

(F)

Figure 2-13 PVK OPERATOR DEPLOYMENT TEST PARTICIPANTS

2.5.4 Duct Comparison

A reinforced plastic material designated T-55, otherwise known as scrim material, was evaluated as a replacement material for the construction of PVK exhaust ducts. The scrim material is a heat compressed laminate of two layers of 3mil thick polyethylene sheet with a grid of 1 mil diameter nylon fiber sandwiched between the two sheets. The fiber grid pattern is approximately .40" x .40".

The scrim material is less susceptible to tearing and shredding than the clear polyethylene. However, it cannot be extruded as a seamless sheet as in the case of polyethylene. A duct made of scrim material will require a heat sealed longitudinal seam along its entire length. The cost of the scrim material is approximately 30 to 40% higher than that of clear polyethylene.

Pressure drop tests conducted in the past[7] on 30" diameter clear polyethylene ducts have yielded a calculated value of 0.003 to 0.006 inch for the absolute roughness of the inside wall of the duct.

The following table shows estimated reductions in flow rate at a given pressure drop in ducts with different absolute roughness.

Reynolds Number	Friction Factor f	Relative Roughness E/D (D=30")	Absolute Roughness E inches	$\frac{V_2^2}{V_1^2} = \frac{F_1}{f_2}$	$\frac{V^2}{V_1} = \frac{Q_2}{Q_1}$
2×10^5 Corresponding to Approx. 2600 cfm flow	0.015	.0003	.009	-	1.0
	0.020	.0010	.030	15/20	.87
	0.024	.0020	.060	15/24	.79
	0.032	.0060	.180	15/32	.70

V_1 is velocity in a smooth duct with E/D up to 0.0003 corresponding to absolute roughness of 0.009 inch.

V_2 is velocity in ducts with greater roughness.

Since the calculated absolute roughness of the clear polyethylene duct is in the range of 0.003 to 0.006 inch, addition of reinforcing fibers of 0.001 inch diameter should not increase the absolute roughness of the duct made of scrim material above the 0.009 inch of the smooth duct shown in the table. Theoretically, therefore, air flow through the scrim material duct should be the same as in the case of clear polyethylene.

However, GARD believes that a duct made of the scrim material should be investigated and tested for actual air flow and the integrity of the longitudinal seam before being incorporated into the production PVK.

Section 3

VENTILATOR KIT, KEARNY PUMP KIT (KPK)

The Kearny pump ventilator[5][8] is shown in Figures 3-1 and 3-2. This ventilator is designed for aperture (doorway) mounting and is suspended from an expandable doorway support bar that provides the pivot hinges for the unit. It consists of a two-piece rectangular frame supporting (16) sixteen polyethelene one-way (valves) flaps and is covered by a coarse wire mesh screen.

The ventilator can be deployed as a full length pump, with both upper and lower sections intact, or as a half length pump by detaching the lower section. The pump is manually actuated by means of an operator pulling the unit with a cord in the direction of air input, and allowing it to backswing through its own momentum.

The doorway support bar assembly is shown in Figures 3-3 and 3-4. The unit provides the support platform and hinge connection for the flap air pump. The support bar is adjustable in length to accommodate all normal doorways from 29.75 to 42.25 inches wide. It incorporates two telescoping tubes and a threaded type handle actuation compression extension. It is packaged fully assembled with its own container which is stored in the Kearny pump storage box.

3.1 Engineering Study - Kearny Pump Kit (KPK)

The objectives of the engineering study for the Kearny pump were identical to those for the pedal ventilator. That is, to conduct a review of the various pump components to determine the areas of potential cost reduction. The study emphasized 'off the shelf' hardware, elimination of machining operations and

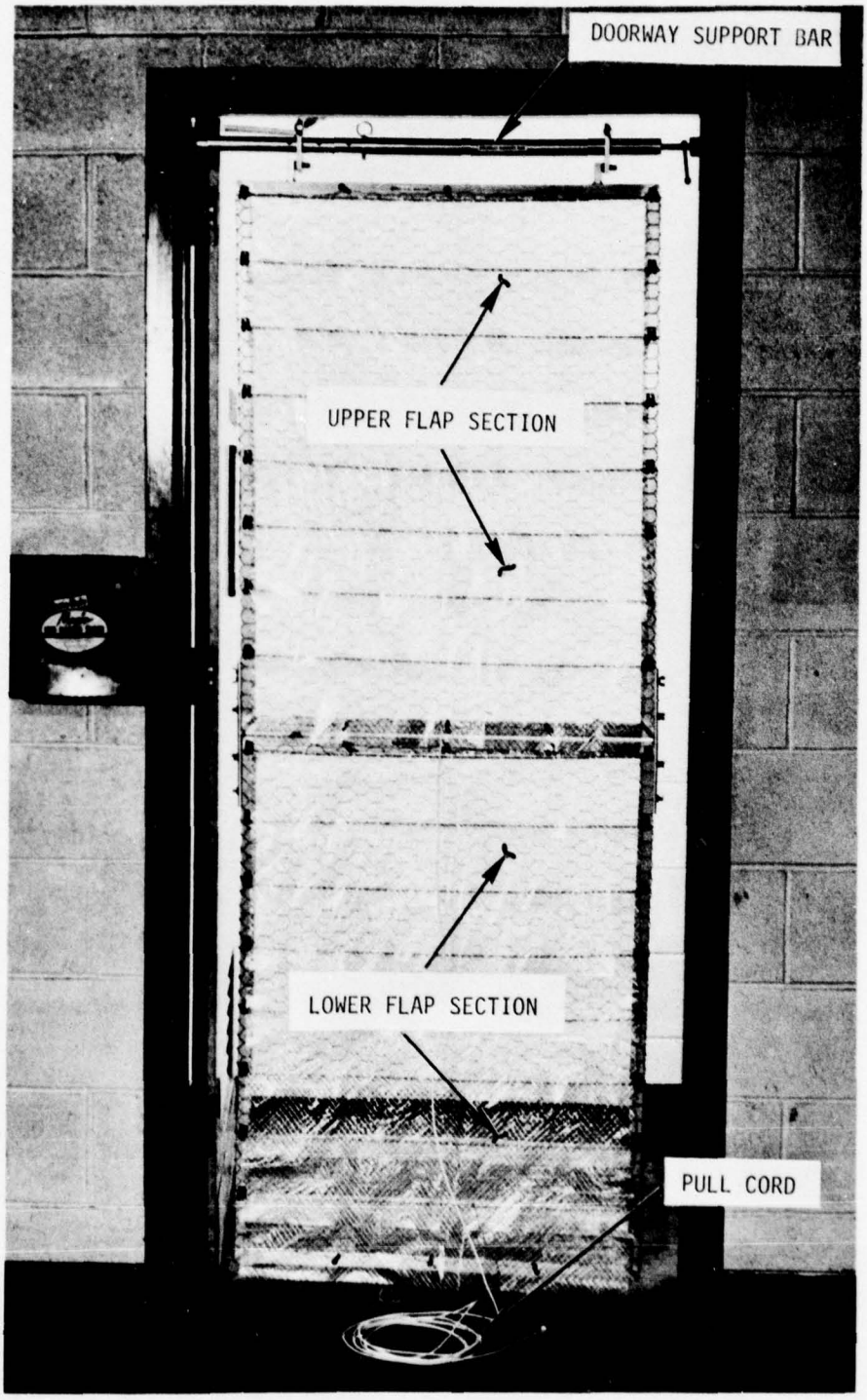


Figure 3-1 VENTILATOR - KEARNY PUMP KIT

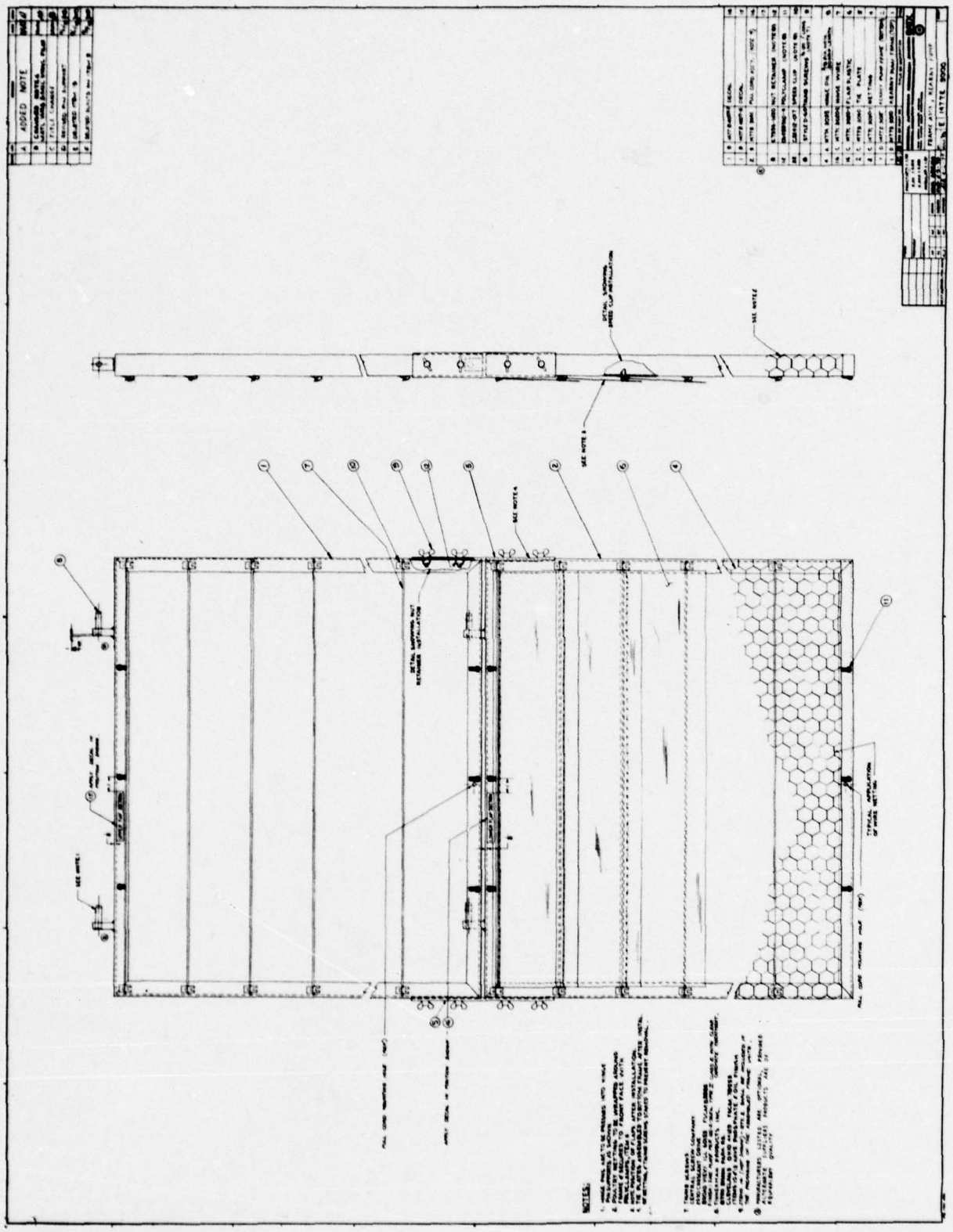


Figure 3-2 VENTILATOR - KEARNY PUMP KIT

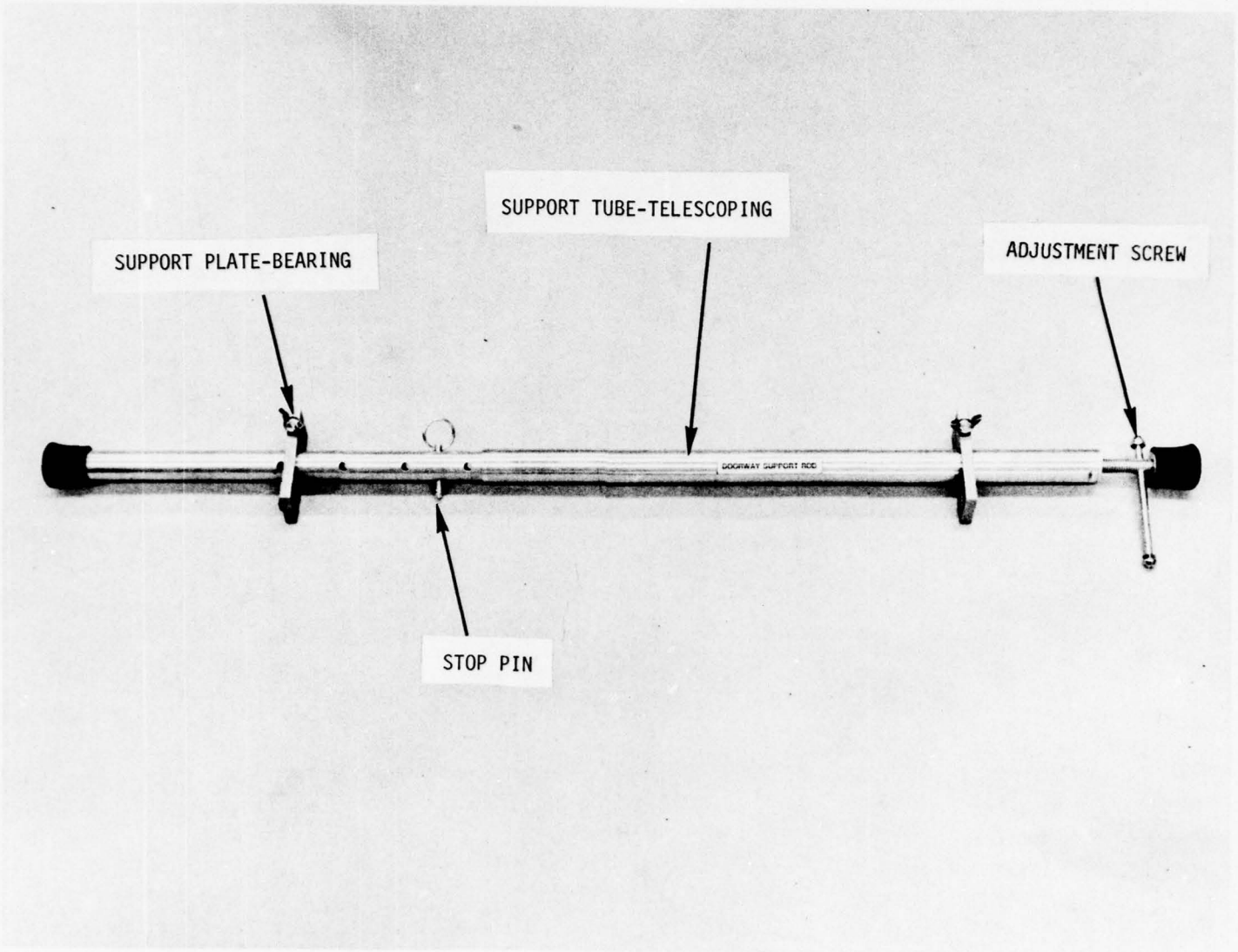


Figure 3-3 DOORWAY SUPPORT BAR, KPK

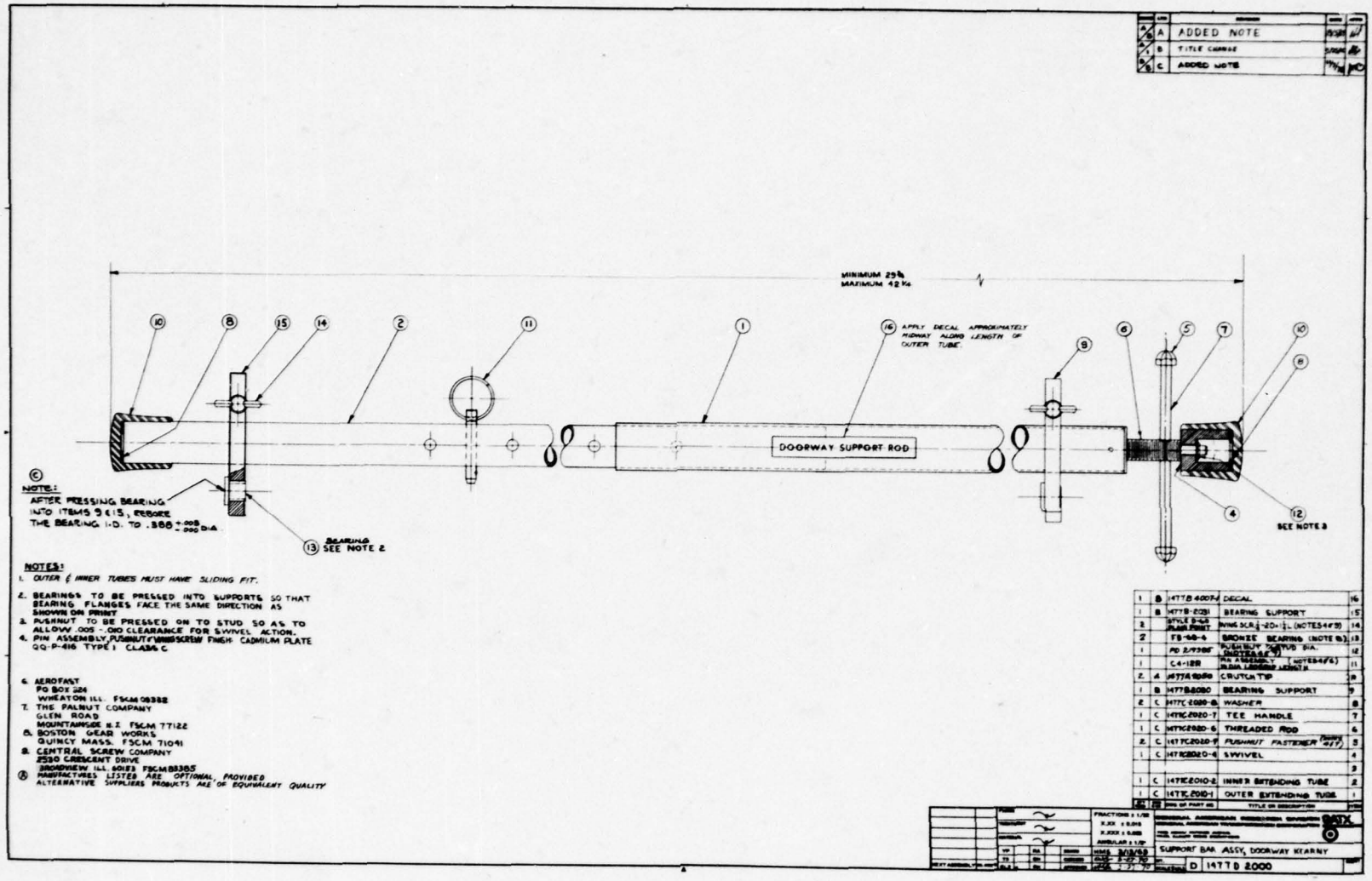


Figure 3-4 DOORWAY SUPPORT BAR, KPK

the reduction of assembly time. No revisions were considered that would detract from the performance, durability or deployment of the kit.

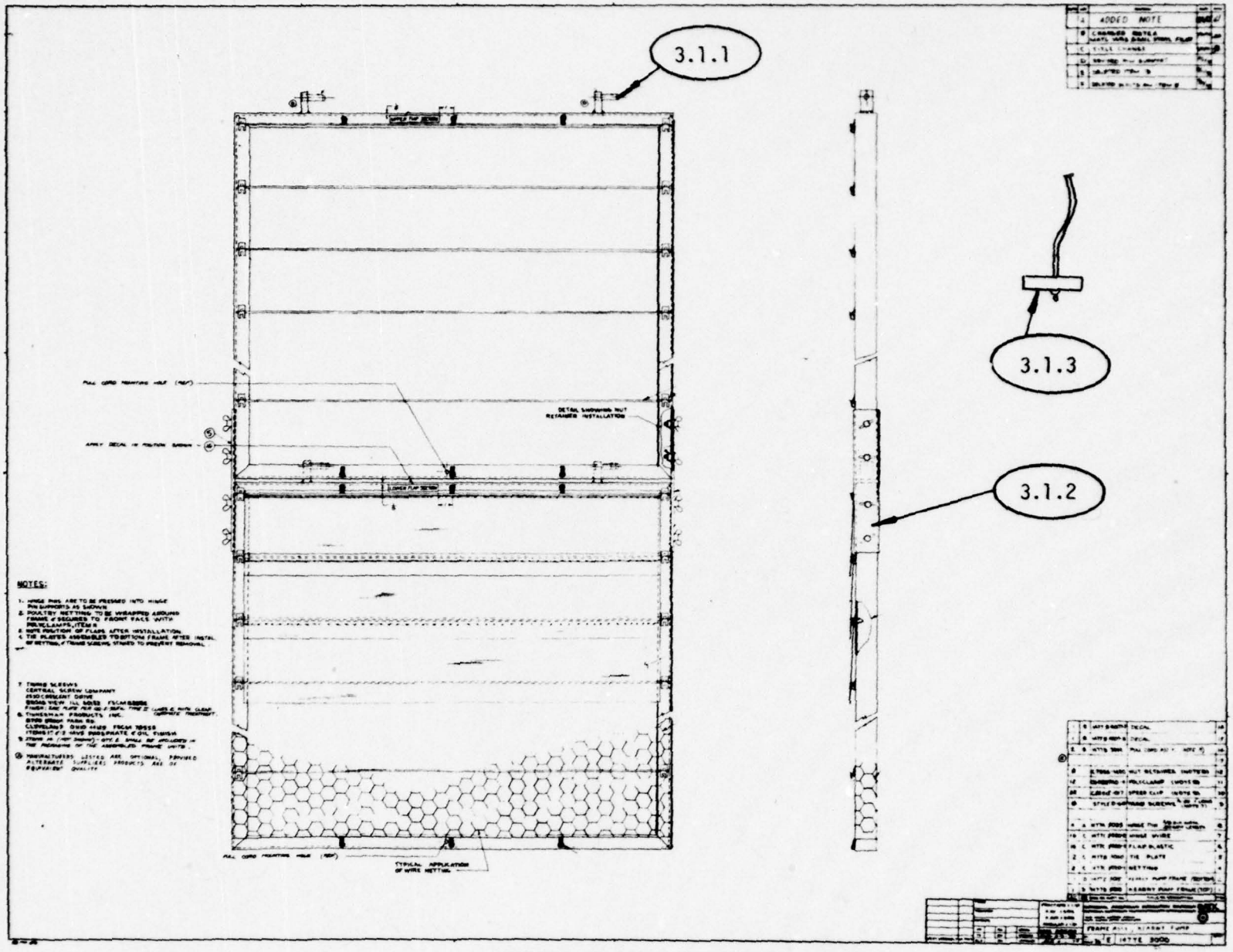
The goal for the engineering study was to reduce the kit unit cost (after inflation) by 10 to 15% from the 1970 configuration.

Due to the inherent simplicity of the previous design, the potential cost reduction revisions found on the flap air pump were considerably fewer in number than the pedal ventilator kit. For example, of the 106 total quantity of parts shown on the Kearny Pump Assembly, Dwg. No. 1477E3000, 102 of the parts are essentially purchased items.

The specific findings of the engineering study for the flap air pump are described in the following subsections. The location of the revision areas discussed are defined by the corresponding paragraph number on Figure 3-5.

3.1.1 Hinge Pin Support - Dwg. No. 1477C3030-2

The subject part provides the support for the hinge pin about which the flap air pump rotates during operation. The part was fabricated from an aluminum extrusion (angle) which measured 1.50 x 1.50 x .39 inches. GARD deleted the extrusion and replaced it with an aluminum block measuring 1.50 x .88 x .38 inches. The block would be fillet welded to the top of the frame along the two .88 inch long sides. This configuration can withstand a tension loading of approximately 1100 pounds for each of the two hinge supports. This is more than adequate for the loads applied during operation of the unit. The estimated savings for each hinge pin support is 45¢ per unit or 1.80 per (4 required) Kearny pump kit.



LOCATION OF REVISION AREAS
VENTILATOR, KEARNY PUMP KIT

Figure 3-5

3.1.2 Tie Plate L.H. - Dwg. No. 1477B3040 and Tie Plate R.H. - Dwg. No. 1477B3041

The tie plates are utilized to provide a rigid structural splice between the upper and lower frame sections. GARD eliminated the three open ended slots on each splice plate and replaced the slots with 9/32" diameter holes. This revision eliminated the necessity of a left and right hand part, and only one part drawing is now required with the quantity required changed to two. The slotted holes did not facilitate assembly of the upper and lower frames to any significant degree. In addition the slots weakened the rigidity of the tie plates.

The above revision resulted in an estimated cost savings of 55¢ per tie plate and $1.10 (2 required) per Kearny pump kit.

3.1.3 Pull Cord - Kearny Pump - Dwg. No. 1477B3042

The previous cord handle was fabricated from maple hardwood. Quotes from wood product suppliers indicated birch would be a more economical material to use for the handle. Birch affords an opportunity to use pre-machined dowel stock which is not available in hard maple. Round steel tubing was also investigated as a candidate material for the handle. The tubing presented potential problems in cutting the cord unless all holes were carefully chamfered on both sides.

The birch material was utilized on the production pull cord with an approximate cost savings of 34¢ per unit.

3.1.4 Doorway Support Bar - Dwg. No. 1477D2000

The doorway support bar provides the support platform and hinge connection for the Kearny pump. The bar is adjustable in length to span across all normal doorways from 29.75 to 42.25 inches wide.

The engineering study conducted on this assembly indicated no significant cost reduction areas were present that did not compromise the structural integrity of the unit under severe operational conditions. The adjustable bearing supports, in particular, were closely examined for substitute methods. Suspending the Kearny pump by means of formed wire, eyelets, nylon rope and sheet metal hangers were investigated. None of the candidates provided all the functional capabilities of the present design, namely, ease of sliding adjustment, rigidity after final adjustment and controlled swinging of the pump without twisting and buffeting. The shape of the bearing support plate can be extruded from aluminum with the large hole, bearing hole and slot intact. The parts will be sliced to width from the extrusion. A secondary operation of drilling and tapping is then required.

3.2 Revision of KPK Drawings, Specifications and Instructions

Based on the data generated in the completed engineering study, GARD incorporated all the valid cost effective revisions to the applicable drawings on the Kearny pump kit. The Military Specifications and operating instructions were updated to reflect any additions or deletions deemed necessary by the changes in the KPK design configuration.

3.2.1 KPK Drawings

The appropriate revisions were made to the original vellums of the KPK drawing package. The revisions were properly recorded on the field of the drawing and the revision block located in the upper right hand corner of the drawing. The drawings were then checked prior to release for fabrication of the prototype kits. Reproducible sepias were made of the subject drawings prior to any revisions to provide any future reference to the previous configuration.

3.2.2 KPK Military Specifications

The Military Specification for the Kearny pump kit was updated to reflect the current revision status of all applicable Federal and Military Specifications and Standards. The drawing list was also revised to indicate any deletions or additions allocated to the engineering study. Quality assurance provisions were checked for conformance to the present KPK configuration. All references to the 'A' frame support, associated drawings and packaging were deleted from the specification. The revised Military Specifications are shown in Appendix 'C' of this report.

3.2.3 KPK Operating Instructions

The KPK operating instructions were reviewed for any revisions deemed necessary. In this case, the revisions were extensive due to the removal of all information regarding the 'A' frame support and its deployment. The entire instruction booklet was redone with new photographs, deletions and rewording of the written instructions.

The revised operating instructions for the KPK are shown in Appendix 'D' of this report.

3.3 Documentation Review - KPK

The KPK Documentation Review Meeting was held simultaneously with the pedal ventilator as discussed in Section 2.3. All drawing changes and Military Specifications were reviewed and discussed. All changes noted as a result of the meeting were incorporated before the start of fabrication.

3.4 Fabrication

Utilizing the updated drawing package, three Kearny pump kits were fabricated and assembled. Any discrepancies noted during the construction of the units were noted and corrected on the original vellums of the drawing package.

The fabricated KPKs included the following deliverables:

Ventilator Kit, Kearny Pump

3 each	Ventilator Kit, Flap Air Pump, as per DCPA Drawing No. 1477J3000
3 each	Pull cord, two each, as per DCPA Drawing No. 1477B3042

Doorway Support Bar

3 each	Ventilator Kit, Doorway Support Bar as per DCPA Drawing No. 1477D2000

Upon completion of the above kits, GARD shipped one kit to DCPA Research and one kit to the Defense Logistics Agency for display and inspection purposes. GARD retained one pedal ventilator kit for testing purposes, which are described in the next section.

3.5 Testing - Kearny Pump Kit (KPK)

Testing of the Kearny pump (KPK) was limited to an operators deployment test held at GARD. Since no component effecting air flow performance was altered by the engineering study for the unit, GARD proposed to conduct a basic smoke tracer test to reconfirm the Kearny air flow distribution. Two methods of determining the air flow for the KPK were attempted with less than satisfactory results.

Air flow tests were initiated, using generated smoke as a tracing element. The smoke generating device utilized was a titanium tetrachloride candle which, when ignited, combines with atmospheric moisture to form a dense, persistent white smoke. The candle was enclosed in a 10-gallon metal drum located downstream of the mounted Kearny pump. The drum had a ventilation hole in the side wall and a flap-covered escapement hole at the top which could be opened and closed to control the desired smoke volume.

During the test, the Kearny pump was oscillated at a rate of approximately 10 cycles per minute. The bottom third of the pump was noted to be sweeping 80% of the smoke volume. The principle problem encountered was the high dispersion rate of smoke into the atmosphere with no lasting propagation of smoke layers for tracing or detection. The position of the smoke container and the volume of smoke was changed several times during the ensuing testing with no significant improvement in smoke trace quantities. It became apparent that the construction of a special enclosure or flow corridor would be necessary for generating reliable air flow data on the Kearny pump. In addition, a more reliable smoke-generating device should be designed for more predictable volume control. The cost associated with the above effort was considered excessive under the current program in lieu of the limited revisions to the unit and the extensive test data compiled under previous DCPA programs.[5][9]

Another air flow test concept was attempted on the Kearny pump with zero gravity balloons. Standards balloons were filled with a sufficient volume of helium to cause the balloons to assume a neutral buoyancy at a predescribed distance above the floor line with zero air flow. Each balloon had a trailing string attached which extended to the floor. The string allowed for 'balancing'

the balloon attitude by regulating the length of string which engaged the floor. The object of the test was to mount the Kearny pump in the far end of an enclosed hall and position the balloons directly upstream of the pump. As the pump is cycled, time/distance measurements would be recorded of the balloon movement to determine the average air velocity generated by the KVK. The primary problems encountered by the above test were as follows:

(1) The balloons contained a considerable static surface charge which resulted in balloons dragging along the vertical walls of the hall and clinging to adjacent balloons.

(2) There was an unequal rate of diffusion (leakage) between individual balloons resulting in varying attitudes and flow patterns of same.

(3) To obtain optimum results, all forced air, ventilation systems and foreign air flow entry must be sealed from the test area. This is extremely difficult to control in a large test facility.

Air flow characteristics that were observed before negative forces (i.e., static) affected the balloon were relatively level (parallel to the floor) flow of the balloons up to 15 feet downstream of the Kearny pump. The implementation of the zero gravity balloon concept for future testing of air moving devices appears to be viable, providing the test area envelope is precisely designed and regulated.

3.5.1 Operator Deployment Test - KPK

As in the case of the PVK, an operator deployment test was performed on the KPK by the same volunteers selected from within GARD's business operations staff. The volunteers were solicited through an interoffice memo similar to

that utilized for the PVK. The 8-hour test was conducted in two morning sessions on 8 March and 9 March 1979 as indicated in the test schedule on Figures 3-6-A and 3-6-B.

The first two participants were required to install the Kearny pump in the doorway using the KPK operating instructions before operating. All remaining participants only operated the unit for the respective 15 minute time frame.

During the installation of the Kearny pump, little difficulty in the sequential assembly of the unit was observed. The KPK was noted to be somewhat awkward for a one-man installation because of the bulk of the Kearny frame.

The entire 8-hour test was conducted using a full Kearny (both top and bottom sections) which requires maximum operator output. The participants operated the KPK at an average rate of 23 cycles per minute and 345 cycles per 15 minute test period. Photos taken during the deployment test are shown in Figure 3-7. Typical comments by the operators upon completion of tests are as follows:

- Arm gets weary after 10 minutes.
- Pushing a swing is easier than pulling the Kearny pump.
- Handle (cord) is uncomfortable, molded rubber handle would be better.
- The upper 4 flaps are relatively inefficient.
- Kearny frame (aluminum) should be reduced in weight.
- Operation is hard on arms and too boring.

OPERATING DOORWAY VENTILATOR

- Face Flaps and pull cord toward you until Flap Section(s) reaches position shown in Figure 1.

- Then let Flap Section(s) swing as far away from you as it will go, as shown in Figure 2.

- Repeat these steps while keeping a constant pace, as you would when pushing a child's swing.

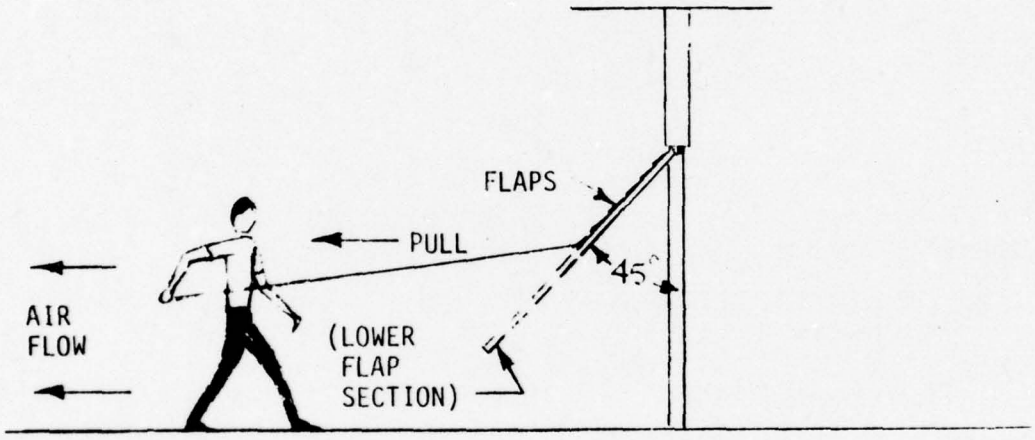
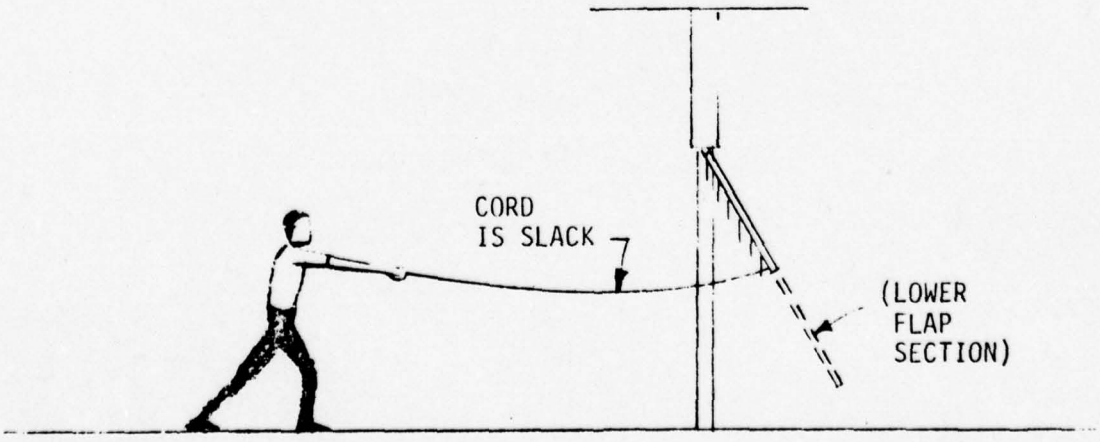


Figure 1



ATTACHMENT "A"

Figure 3-6-A

GATX GARD, INC.

TO Distribution

DATE 27 Feb. 1979
1703

FROM J. M. Buday JMB

SUBJECT KEARNY PUMP KIT TEST
(two morning sessions on 8 March and 9 March, 1979)

8:00	-	8:15	(1)	G. Zima
8:15	-	8:30	(2)	J. McGreevy
8:30	-	8:45	(3)	A. Horneck
8:45	-	9:00	(4)	W. Graycyzk
9:00	-	9:15	(5)	M. Zeszutko
9:15	-	9:30	(6)	G. Sullivan
9:30	-	9:45	(7)	M. Potts
9:45	-	10:00	(8)	S. Chrapkowski
10:00	-	10:15	(1)	G. Zima
10:15	-	10:30	(2)	J. McGreevy
10:30	-	10:45	(3)	A. Horneck
10:45	-	11:00	(4)	W. Graycyzk
11:00	-	11:15	(5)	M. Zeszutko
11:15	-	11:30	(6)	G. Sullivan
11:30	-	11:45	(7)	M. Potts
11:45	-	12:00	(8)	S. Chrapkowski

NOTE: Please contact me if the time allotments conflict with your schedule. Wear appropriate clothing for test.

OPERATING INSTRUCTIONS:

See Attachment "A" for operating instructions.

JMB:hr

KPK TEST SCHEDULE

Figure 3-6-B

(A)

(B)

(C)

(D)

(E)

Figure 3-7 KPK OPERATOR DEPLOYMENT TEST PARTICIPANTS

Observations made by the Test Monitor during the performance of the test include the following:

- o All operators except one switched pulling-hands at some time during the operation.
- o Most operators adapted to the natural frequency (swing) of the Kearny pump within 30 seconds.
- o The amplitude (angular displacement) of the Kearny pump was greater for men than women in the power stroke.
- o Air flow generated by the Kearny pump is easily detectable 30 to 35 yards downstream of the unit. It also provides a cooling effect for the operator with each cycle.

No mechanical failure or wear of the Kearny pump was noted at the conclusion of the 8-hour test. The unit, as designed, will easily endure operational service. The inclusion of reinforced plastic flaps and two sets of pull-cords have greatly enhanced the service life of the unit.

Section 4

PRODUCTION COST ESTIMATE

Estimates of production costs for the Pedal Ventilator Kit (PVK) and Kearny Pump Kit (KPK) were made based upon procurement quantities of 10,000 units each. The estimates made update those made in 1970 and include not only inflation realized since then, but also the reduction in costs due to improvements made as a result of this program.

GARD's Technical Products group assisted the engineering department with estimates of purchased parts, materials and services. Their computerized "Bill of Material" and "Summarized Material Requirements" programs were utilized to tabulate, extend and totalize these estimates for each kit. GARD's Technical Products group is involved in the production and light manufacture of new products developed by GARD's engineering group.

The cost summaries for both the PVK, Figure 4-1, and the KPK, Figure 4-4, includes materials, accessories, labor, burdens, profit and represents the total estimated procurement cost for complete kits. The computer printouts for the PVK and KPK Bill of Material and Summarized Material Requirements are shown in Figures 4-2, 4-3, and Figures 4-5, 4-6, respectively.

The tooling cost for the PVK was estimated at $11,900 and amortized over 10,000 units (approximately $1.20/unit). The cost estimate for the PVK in 1970 was $121.65. The estimated cost for this same configuration in 1979 is estimated as:

PVK (1970 Configuration)

LABOR:	2 hrs, 5 min. @ $25/hr	$ 52.08	
MATERIALS:	$150.72		
MTL. BURDEN:	15.82		
G&A:	11.08		
TOTAL MATERIAL:		$177.62	
TOTAL COST:			$229.70
PROFIT			22.97
TOTAL PRICE:*			$252.67

The cost of the PVK as a result of this program is estimated as:

PVK (1979 Configuration)

LABOR:	1 hr, 35 min. @$25/hr	$ 39.58	
MATERIALS:	$138.87		
MTL. BURDEN:	14.58		
G&A:	10.20		
TOTAL MATERIAL:		$163.65	
TOTAL COST:			$203.23
PROFIT:			20.32
TOTAL PRICE:*			$223.55

* Per unit in 10,000 quantity buys, April, 1979.

The tooling costs for the KPK were estimated at $6,700 and amortized over 10,000 units (approximately 60¢/unit). The cost estimate for the KPK in 1970 was:

Total Cost:	$ 33.79		
G&A:	1.69		
Subtotal:		$ 35.48	
Profit:		5.32	
Total Price:			$ 40.80

The cost for this same configuration in 1979 was estimated as:

KPK (1970 Configuration)

LABOR:	35 min. @ $25/hr		$ 14.58	
MATERIALS:	Frame -	$38.24		
	Bar -	13.385		
	Cord - & Misc.	3.52		
			$ 55.145	
MATERIAL BURDEN:			5.79	
G&A:			4.05	
TOTAL MATERIAL COST:			$ 64.99	
TOTAL COST:				$ 79.57
PROFIT:				7.96
TOTAL PRICE:				$ 87.52

The cost of the KPK as a result of this program is estimated as:

KPK (1979 Configuration)

LABOR:	30 min. @ $25/hr	$ 12.50	
MATERIALS:	Frame - $ 35.34 Bar - 13.385 Cord - 2.84 & Misc.		
TOTAL MATERIAL:		$ 51.565	
MATERIAL BURDEN:		5.41	
G&A:		3.79	
TOTAL MATERIAL COST:		$ 60.77	
TOTAL COST:			$ 73.27
PROFIT:			7.33
TOTAL PRICE:*			$ 80.60

* Per unit in 10,000 quantity buys, April, 1979.

1979 PRODUCTION COST ESTIMATES

(10,000 UNIT PROCUREMENT)

PEDAL VENTILATOR KIT - (PVK)

FRAME ASSEMBLY - 1477E6010

Dwg. No.	Qty. Reqd.	Description	Cost Ea.	Cost Per Assy	
1744C6011	1	Front Leg Support	$ 8.40	$ 8.40	
1477B6012	1	Rear Support Leg	1.50	1.50	
1477B6013	1	Fan Support Bar	4.50	4.50	
1477B6014	2	Foot, Support	1.85	3.70	
1477B6015	1	Hanger, Crank	1.10	1.10	
1477A6017	1	Saddle Support Stem	.55	.55	
RN3316	1	Weld Nut - 3/8-16	.03	.03	
3040-BH	1	Knob, THD Stud	.19	.19	
-	A/R	Painting Per Spec	1.80	1.80	
	SUBTOTAL	MATERIALS - FRAME ASSEMBLY			$ 21.77
1477E6010	A/R	Labor - Welding	8.33	8.33	
1477E6010	A/R	Labor - Mach. & Painting	14.58	14.58	
	SUBTOTAL	LABOR - FRAME ASSEMBLY			$ 22.91

PEDAL VENTILATOR ASSEMBLY - 1477J6000

1477C6018	1	Handle Bar Assy.	$ 3.80	$ 3.80	
1477C6019	1	Drive Sprocket	11.71	11.71	
1477B6020	1	Sprocket, Fan Shaft	2.28	2.28	
1477B6021	1	Fan Shaft	1.25	1.25	
1477D6022	1	Shroud, Fan	28.50	28.50	
1477D6023	2	Guard, Fan	3.24	6.48	

Figure 4-1

PEDAL VENTILATOR KIT

(Continued)

Dwg. No.	Qty Reqd.	Description	Cost Ea.	Cost Per Assy	
1477B6026-1	1	Decal	$ .02	$ .02	
1477B6026-2	1	Decal	.02	.02	
1477B6026-3	1	Decal	.02	.02	
1477B6026-4	1	Decal	.26	.26	
Commercial	1	Crank Assembly	10.76	10.76	
"	1	Bearing & Collar	4.07	4.07	
"	4	Flangettes	.14	.56	
"	1	Fan - 30" Dia.	15.54	15.54	
"	1	Chain, Roller	5.81	5.81	
"	1	Spring Pin	.04	.04	
"	1	Saddle	1.85	1.85	
"	1	Pedals (Pair)	1.20	1.20	
"	2	Grips	.06	.12	
"	1	Bearing - No Collar	3.74	3.74	
"	4	Screw - 10-32 x 2-1/2"	.04	.16	
"	10	Screw - 8-32 x 5/8"	.01	.10	
"	2	Bolt, Carr 5/16-18 x 3"	.05	.10	
"	2	Nut, Self Lock 5/16-18	.03	.06	
"	4	Nut, Self Lock 10-32	.02	.08	
"	10	Nut, Self Lock 8-32	.02	.20	
"	10	Washer, Flat #8	.01	.10	
"	2	Washer, Flat #5/16	.01	.02	
-	A/R	Misc. Painting & Plating	1.85	1.85	
	SUBTOTAL MATERIALS - PEDAL VENTILATOR ASSEMBLY				$100.70
1477J6000	A/R	Labor - Final Assembly	$12.50	$12.50	
	SUBTOTAL LABOR - PEDAL VENTILATOR ASSEMBLY				$ 12.50

Figure 4-1 (Continued)

PEDAL VENTILATOR KIT
(Continued)

DUCT

Dwg. No.	Qty Reqd.	Description	Cost Ea.	Cost Per Assy	
Commercial	1	Polyethelene Duct 31" x .004 x 50 Ft.	$ 4.20	$ 4.20	
Commercial	1	Packaging	.85	.85	
	SUBTOTAL - DUCT				$ 5.05

ACCESSORIES

Commercial	1	Duct Tape 2" x 30 Yds.	$ 1.70	$ 1.70	
"	1	Scissors - 4"	.45	.45	
"	1	Lubricating Oil - 1-1/2 oz.	.20	.20	
"	1	Polethelene Bag	.50	.50	
	SUBTOTAL - ACCESSORIES				$ 2.85

INSTRUCTION BOOKLET

Commercial Printing House	1	Instruction Booklet	$ .45	$ .45	
	SUBTOTAL - INSTRUCTION BOOKLET				$ .45

PACKAGING

Commercial	1	Inner Box	$ 1.80	$ 1.80	
Commercial	1	Outer Box	3.25	3.25	
Commercial	1	Vapor Barrier	1.25	1.25	
1477A6024	1	Wood Lattice	1.75	1.75	
	SUBTOTAL MATERIAL - PACKAGING				$ 8.05
-	A/R	Labor - Packaging	$ 4.17	$ 4.17	
	SUBTOTAL LABOR - PACKAGING				$ 4.17

Figure 4-1 (Continued)

PEDAL VENTILATOR KIT (1979 Configuration) TOTALS

Labor: 1 hr 35 min. @ $25/hr		$ 39.58	
Materials:	$138.87		
Material Burden:	14.58		
G&A	10.20		
TOTAL MATERIAL		$163.65	
TOTAL COST			$203.23
PROFIT			20.32
TOTAL PRICE*			$223.55

* Per unit in 10K quantity buys, April 1979.

Figure 4-1 (Continued)

BILL OF MATERIAL FOR 16515 MA ONE-OPERATOR PEDAL VENTILAT REV. 12/31/ 0 EXTENDED FOR 10000. UNIT(S) 2/23/79
J1477J6000 PAGE 1

LEVEL OF ASSEMBLY	* * * PART NUMBER * * *	DWG. NO.	* * * * DESCRIPTION * * * *		QTY/ASS'Y	EXT'D QTY	
0	16516	E1477E6010	MA FRAME ASSY		1.0	10000.0	12/31/ 0
1	16545	C1477C6011	SU FRONT LEG		1.0	10000.0	
1	16546	B1477B6012	SU REAR LEG		1.0	10000.0	
1	16547	B1477B6013	SU FAN BAR		1.0	10000.0	
1	16548	B1477B6014	SU FOOT		2.0	20000.0	
1	16549	B1477B6015	MP CRANK HANGER		1.0	10000.0	
1	16552		NT ST 3/8-16	WELD	1.0	10000.0	
1	16550		HW STUD KNOB 3/8 16x1	H. DAVIS	1.0	10000.0	
1	16551	B1477B6017	SU SADDLE STEM		1.0	10000.0	
0	16517	C1477C6018	MA HANDLE BAR ASSY		1.0	10000.0	
0	16518	C1477C6019	MP SPROCKET, DRIVE		1.0	10000.0	
0	16520	B1477B6021	MP SHAFT, FAN		1.0	10000.0	
0	16521	D1477D6022	MP SHROUD, FAN		1.0	10000.0	
0	16522	D1477D6023	MP GUARD, FAN		2.0	20000.0	
0	16523		HW FLANGETTES	FAFNIR	4.0	40000.0	
0	16524		MP SADDLE	MESINGER	1.0	10000.0	
0	16525		MP CRANK	SCHWINN	1.0	10000.0	
0	16530	SA35	GR CHAIN	DIAMOND	1.0	10000.0	
0	16531		MP FAN 30 DIA 3/4 DIA	HUB	1.0	10000.0	
0	16532		HW SPRING PIN 1 1/4	ABBOTT	1.0	10000.0	
0	16533		SW ZN PN 10 32x2 1/2	MACHINE	4.0	40000.0	
0	16534		SW ZN PN 8 32X5/8	MACHINE	10.0	100000.0	
0	16535		MP PEDALS, FOOT	SCHWINN	1.0	10000.0	
0	16536		BO ZN RD 15/16 18X3	ABBOTT	2.0	20000.0	
0	16537		PT GRIPS 4 5/8	ACE MOLD	2.0	20000.0	
0	16538		GR BEARING & COLLAR	FAFNIR	1.0	10000.0	
0	16539		GR BEARING	FAFNIR	1.0	10000.0	
0	16540	B1477B6026-1	LL ONE-OPERATOR PEDAL	VENTILAT	1.0	10000.0	
0	16541	B1477B6026-2	LL ONE-OPERATOR PEDAL	VENTILAT	1.0	10000.0	
0	16542	B1477B6026-3	LL ONE-OPERATOR PEDAL	VENTILAT	1.0	10000.0	
0	16543	B1477B6026-4	LL ONE-OPERATOR PEDAL	VENTILAT	1.0	10000.0	
0	16544	A1477A6024	PM WOOD LATTICE BOX		1.0	10000.0	
0	16555		WR FL	ABBOTT	2.0	20000.0	
0	16556		NT SELF-LOCKING 15/16-18		2.0	20000.0	
0	16557		NT SELF-LOCKING 10-32		4.0	40000.0	
0	16558		NT SELF-LOCKING 8-32		10.0	100000.0	
0	16559		WR ST FL # 8		10.0	100000.0	
0	16595	B1477B6020	MP SPROCKET, FAN SHAFT		1.0	10000.0	
0	16719		PL PLATING&FINISHING		1.0	10000.0	
0	16720		DT DUCT POLY		1.0	10000.0	
0	16721		AC ACCESORY		1.0	10000.0	
0	16722		MN MANUAL & INSTRUCTIONS		1.0	10000.0	
0	16723		PK PACKAGING		1.0	10000.0	

Figure 4-2 PEDAL VENTILATOR KIT COMPUTER PRINTOUT

SUMMARIZED MATERIAL REQUIREMENTS FOR 2/23/79 PAGE 1

ONE OPERATOR PEDEAL VENTILATOR

PART NO.	* * * * DESCRIPTION * * * *		DWG. NO.	QUANTITY REQUIRED	UNIT COST	EXTND COST
2-28-16516	MA FRAME ASSY		E1477E6010	10000.0	ASSEMBLY	
2-28-16517	MA HANDLE BAR ASSY		C1477C6018	10000.0	3.8000	38000.00
2-23-16518	MP SPROCKET, DRIVE		C1477C6019	10000.0	11.7100	117099.99
2-23-16520	MP SHAFT, FAN		B1477B6021	10000.0	1.2500	12500.00
2-23-16521	MP SHROUD, FAN		D1477D6022	10000.0	28.5000	285000.00
2-23-16522	MP GUARD, FAN		D1477D6023	20000.0	3.2400	64799.99
1-26-16523	HW FLANGETTES	FAFNIR		40000.0	0.1400	5599.99
1-23-16524	MP SADDLE	MESINGER		10000.0	1.8500	18500.00
1-23-16525	MP CRANK	SCHWINN		10000.0	10.7600	107600.00
1-27-16530	GR CHAIN	DIAMOND	SA35	10000.0	5.8100	58100.00
1-23-16531	MP FAN 30 DIA 3/4 DIA	HUB		10000.0	15.5400	155400.00
1-26-16532	HW SPRING PIN 1 1/4	ABBOTT		10000.0	0.0400	400.00
1-26-16533	SW ZN PN 10 32X2 1/2	MACHINE		40000.0	0.0400	1600.00
1-26-16534	SW ZN PN 8 32X5/8	MACHINE		100000.0	0.0100	999.99
1-23-16535	MP PEDALS, FOOT	SCHWINN		10000.0	1.2000	12000.00
1-26-16536	RO ZN RD 15/16 18X3	ABBOTT		20000.0	0.0500	1000.00
1-34-16537	PT GRIPS 4 5/8	ACE MOLD		20000.0	0.0600	1200.00
1-27-16538	GR BEARING & COLLAR	FAFNIR		10000.0	4.0700	40699.99
1-27-16539	GR BEARING	FAFNIR		10000.0	3.7400	37400.00
2-40-16540	LL ONE-OPERATOR PEDAL	VENTILAT	B1477B6026-1	10000.0	0.0200	200.00
2-40-16541	LL ONE-OPERATOR PEDAL	VENTILAT	B1477B6026-2	10000.0	0.0200	200.00
2-40-16542	LL ONE-OPERATOR PEDAL	VENTILAT	B1477B6026-3	10000.0	0.0200	200.00
2-40-16543	LL ONE-OPERATOR PEDAL	VENTILAT	B1477B6026-4	10000.0	0.2300	2300.00
2-35-16544	PM WOOD LATTICE BOX		A1477A6024	10000.0	1.7500	17500.00
2-22-16545	SU FRONT LEG		C1477C6011	10000.0	8.4000	84000.00
2-22-16546	SU REAR LEG		B1477B6012	10000.0	1.5000	15000.00
2-22-16547	SU FAN BAR		B1477B6013	10000.0	4.5000	45000.00
2-22-16548	SU FOOT		B1477B6014	20000.0	1.8500	37000.00
2-23-16549	MP CRANK HANGER		B1477B6015	10000.0	1.1000	11000.00
1-26-16550	HW STUD KNOB 3/8 16X1	H. DAVIS		10000.0	0.1900	1900.00
2-22-16551	SU SADDLE STEM		B1477B6017	10000.0	0.5500	5500.00
1-26-16552	NT ST 3/8-16	WELD		10000.0	0.0300	300.00
1-26-16555	WR FL	ABBOTT		20000.0	0.0100	200.00
1-26-16556	NT SELF-LOCKING 15/16-18			20000.0	0.0300	600.00
1-26-16557	NT SELF-LOCKING 10-32			40000.0	0.0200	800.00
1-26-16558	NT SELF-LOCKING 8-32			100000.0	0.0200	1999.99
1-26-16559	WR ST FL # 8			100000.0	0.0100	999.99
2-23-16595	MP SPROCKET, FAN SHAFT		B1477B6120	10000.0	2.2800	22800.00
3-23-16719	PL PLATING&FINISHING			10000.0	3.6500	36500.00
2-35-16720	DT DUCT POLY			10000.0	5.0500	50500.00
2-22-16721	AC ACCESORY			10000.0	2.8500	28500.00
2-40-16722	MN MANUAL & INSTRUCTIONS			10000.0	0.4500	4500.00
2-35-16723	PK PACKAGING			10000.0	6.3000	63000.00
					GRAND TOTAL $	1388399.89

Figure 4-3 PEDAL VENTILATOR KIT COMPUTER PRINTOUT

1979 PRODUCTION COSTS ESTIMATES

(10,000 UNIT PROCUREMENT)

KEARNY PUMP KIT (KPK)

KEARNY PUMP FRAME - 1477E3000

Dwg. No.	Qty Reqd.	Description	Cost Ea.	Cost Per Assy	
1477D3010	1	Frame, Top	$ 8.50	$ 8.50	
1477D3015	1	Frame, Bottom	8.75	8.75	
1477B3040	2	Tie Plate	.75	1.50	
1477C3030-1	2	Netting	.56	1.12	
1477C3030-2	4	Hinge Pin Support	.75	3.00	
1477C3020-1	16	Flap, Plastic	.32	5.12	
1477C3020-2	16	Hinge Wire	.20	3.20	
1477A3035	4	Hinge Pin	.37	1.48	
Commercial	8	Thumbscrew 1/4-20 x 1"	.05	.40	
Commercial	32	Speedclip	.03	.96	
Commercial	12	Polyclamp	.02	.24	
Commercial	8	Nut, Retainer 1/4-20	.04	.32	
1477B4007-6	1	Decal	.05	.05	
1477B4007-7	1	Decal	.05	.05	
1477E3000	A/R	Plating/Finishing	.65	.65	
	SUBTOTAL	MATERIALS - FRAME ASSEMBLY			$ 35.34
1477E3000	A/R	Labor - Assy/Welding	$ 8.33	$ 8.33	
	SUBTOTAL	LABOR - FRAME ASSEMBLY			$ 8.33

Figure 4-4

KEARNY PUMP KIT
(Continued)

DOORWAY SUPPORT BAR - 1477D2000

Dwg. No.	Qty Reqd.	Description	Cost Ea.	Cost Per Assy	
1477C2010-1	1	Outer Extending Tube	$ .96	$ .96	
1477C2010-2	1	Inner Extending Tube	2.65	2.65	
1477C2020-3	1	End Plug	.75	.75	
1477C2020-4	1	Swivel	.64	.64	
1477C2020-6	1	Threaded Rod	.60	.60	
1477C2020-7	1	Tee Handle	.07	.07	
1477C2020-8	1	Washer, End	.005	.005	
1477B2030	1	Bearing Support	3.20	3.20	
1477B2031	1	Bearing Support	3.20	3.20	
1477A2050	2	Crutch Tip	.10	.20	
Commercial	1	Pin Assembly	.29	.29	
1477C2020-9	2	Push Nut	.02	.04	
Commercial	2	Bearing, Bronze	.08	.16	
Commercial	2	Wing Screw 1/20 x 1"	.03	.06	
Commercial	2	Push Nut - 7/32 Stud	.02	.04	
1477B4007-1	1	Decal	.02	.02	
1477D2000	1	Plating	.18	.18	
1477D2000	1	Packaging	.32	.32	
	SUBTOTAL MATERIALS - SUPPORT BAR				$ 13.385
1477D2000	A/R	Labor - Assembly	$ 2.08	$ 2.08	
	SUBTOTAL LABOR - SUPPORT BAR				$ 2.08

Figure 4-4 (Continued)

KEARNY PUMP KIT
(Continued)

PULL CORD AND MISC.

Dwg. No.	Qty Reqd.	Description	Cost Ea.	Cost Per Assy	
1477B3042	2	Pull Cord Assembly	$ .37	$ .74	
Commercial Printing House	1	Instruction Booklet	.35	.35	
		SUBTOTAL MATERIALS - PULL CORD & MISC.			$ 1.09

PACKAGING

Commercial	1	Packaging	$ 1.75	$ 1.75	
		SUBTOTAL MATERIALS - PACKAGING			$ 1.75
-	A/R	Labor - Packaging	$ 2.09	$ 2.09	
		SUBTOTAL LABOR- PACKAGING			$ 2.09

KEARNY PUMP KIT (1979 Configuration) TOTALS

SUBTOTAL LABOR: 30 min. @ $25/hr = $12.50		$12.50
SUBTOTAL MATERIALS & SERVICES		
Frame - $35.34		
Bar - 13.385		
Cord & Misc. - 2.84		
SUBTOTAL	$51.565	
Materials Burden	5.41	
G&A	3.79	
TOTAL MATERIAL COST	$60.77	
TOTAL COST		$73.27
PROFIT		7.33
TOTAL PRICE*		$80.60

* Per unit in 10K quantity buys, April 1979.

Figure 4-4 (Continued)

BILL OF MATERIAL FOR 16594 MA KEARNY PUMP ASSY REV. 12/31/ 0 EXTENDED FOR 10000. UNIT(S) 2/23/79
PAGE 1

LEVEL OF ASSEMBLY	* * * PART NUMBER * * *	DWG. NO.	* * * * DESCRIPTION * * * *	QTY/ASS'Y	EXT'D QTY	
0	16577	D1477D2000	MA SUPPORT BAR ASSY-KEARNY PUM	1.0	10000.0	12/31/ 0
1	16578	C1477C2010-1	PI TUBE, OUTER EXTENDING	1.0	10000.0	
1	16579	C1477C2020-3	PI PLUG, END	1.0	10000.0	
1	16580	C1477C2010-2	PI TURE, INNER EXTENDING	1.0	10000.0	
1	16581	C1477C2020-4	MP SWIVEL	1.0	10000.0	
1	16582	C1477C2020-9	NT PUSH FASTENER	2.0	20000.0	
1	16583	C1477C2020-6	HW ROD THREADED	1.0	10000.0	
1	16584	C14772020-7	MC HANDLE TEE	1.0	10000.0	
1	16585	C1477C2020-8	WR ST 3/8 PLAIN	2.0	20000.0	
1	16586	B147782030	SU BEARING, OUTER TUBE	1.0	10000.0	
1	16587	A1477A2050	RP NEOPRENE CRUTCH TIP	2.0	20000.0	
1	16588		HW PIN ASSY 1/4X1.20 AEROFAST	1.0	10000.0	
1	16589		NT 7/32 STUD, PUSH	1.0	10000.0	
1	16590		GR BEARING BRONZE	2.0	20000.0	
1	16591		SW 1/4 20X1 1/4 WING	2.0	20000.0	
1	16592	B147782031	SU BEARING, INNER TUBE	1.0	10000.0	
1	16593	B1477B4007-1	LL SUPPORT BAR ASSY-KEARNY PUM	1.0	10000.0	
0	16560	E1477E3000	MA KEARNY PUMP FRAME ASSY	1.0	10000.0	12/31/ 0
1	16574	A1477A3035	HW HINGE PIN 3/8X.90	4.0	40000.0	12/31/ 0
2	16575	A1477A3035	HW HINGE PIN	1.0	40000.0	
1	16561	D1477D3010	FMP FRAME, TOP SECTION	1.0	10000.0	
1	16562	D1477D3015	FMP FRAME, BOTTOM SECTION	1.0	10000.0	
1	16563	D1477D3040	PL TIE	2.0	20000.0	
1	16564		SW ZN 1/4 20X1 THUMB	8.0	80000.0	
1	16565		HW SPEED CLIP TINNERMAN	32.0	320000.0	
1	16566		HW POLYCLAMP TINNERMAN	12.0	120000.0	
1	16567		NT RETAINER TINNERMAN	8.0	80000.0	
1	16568	B1477B3042	MA PULL CORD ASSY	2.0	20000.0	
1	16569	B1477B4007-6	LL KEARNY PUMP ASSY	1.0	10000.0	
1	16570	B1477B4007-7	LL KEARNY PUMP ASSY	1.0	10000.0	
1	16571	C1477C3030-1	MM NETTING	2.0	20000.0	
1	16572	C1477C3020-1	PT FLAP	16.0	160000.0	
1	16573	C1477C3020-2	WE HINGE	16.0	160000.0	
1	16576	C1477C3030-2	SU HINGE PIN	4.0	40000.0	
0	16724		PL PLATING & FINISHING	1.0	10000.0	
0	16725		MN MANUAL & INSTRUCTIONS	1.0	10000.0	
0	16726		PK PACKAGING	1.0	10000.0	

Figure 4-5 KEARNY PUMP COMPUTER PRINTOUT

SUMMARIZED MATERIAL REQUIREMENTS FOR 2/23/79 PAGE 1

KEARNY PUMP ASSEMBLY

PART NO.	* * * * DESCRIPTION * * * *	DWG. NO.	QUANTITY REQUIRED	UNIT COST	EXTD COST
2-28-16560	MA KEARNY PUMP FRAME ASSY	E1477E3000	10000.0	ASSEMBLY	
2-22-16561	FMP FRAME, TOP SECTION	D1477D3010	10000.0	8.5000	85000.00
2-22-16562	FMP FRAME, BOTTOM SECTION	D1477D3015	10000.0	8.7500	87500.00
2-22-16563	PL TIE	D1477D3040	20000.0	0.7500	15000.00
1-26-16564	SW ZN 1/4 20X1 THUMB		80000.0	0.0500	4000.00
1-26-16565	HW SPEED CLIP TINNERMAN		320000.0	0.0300	9600.00
1-26-16566	HW POLYCLAMP TINNERMAN		120000.0	0.0200	2400.00
1-26-16567	HT RETAINER TINNERMAN		80000.0	0.0400	3200.00
2-26-16568	MA PULL CORD ASSY	B1477B3042	20000.0	0.3700	7400.00
2-40-16569	LL KEARNY PUMP ASSY	B1477B4007-6	10000.0	0.0500	500.00
2-40-16570	LL KEARNY PUMP ASSY	B1477B4007-7	10000.0	0.0500	500.00
1-39-16571	MM NETTING	C1477C3030-1	20000.0	0.5600	11199.99
2-34-16572	PT FLAP	C1477C3020-1	160000.0	0.3200	51200.00
2-18-16573	WE HINGE	C1477C3020-2	160000.0	0.2000	32000.00
2-26-16574	HW HINGE PIN 3/8X.80	A1477A3035	40000.0	ASSEMBLY	
1-26-16575	HW HINGE PIN	A1477A3035	40000.0	0.3700	14800.00
2-22-16576	SU HINGE PIN	C1477C3030-2	40000.0	0.7500	30000.00
2-28-16577	MA SUPPORT BAR ASSY-KEARNY PUM	D1477D2000	10000.0	ASSEMBLY	
2-33-16578	PI TUBE, OUTER EXTENDING	C1477C2010-1	10000.0	0.9600	9600.00
2-33-16579	PI PLUG, END	C1477C2020-3	10000.0	0.7500	7500.00
2-33-16580	PI TUBE, INNER EXTENDING	C1477C2010-2	10000.0	2.6500	26500.00
2-23-16581	MP SWIVEL	C1477C2020-4	10000.0	0.6400	6400.00
1-26-16582	NT PUSH FASTENER	C1477C2020-9	20000.0	0.0200	400.00
2-26-16583	HW ROD THREADED	C1477C2020-6	10000.0	0.6000	6000.00
2-29-16584	MC HANDLE TEE	C14772020-7	10000.0	0.0700	699.99
1-26-16585	NR ST 3/8 PLAIN	C1477C2020-8	20000.0	0.0050	100.00
2-22-16586	SU BEARING, OUTER TUBE	B1477B2030	10000.0	3.2000	32000.00
2-36-16587	RP NEOPRENE CRUTCH TIP	A1477A2050	20000.0	0.1000	2000.00
1-26-16588	HW PIN ASSY 1/4x1.20 AEROFAST		10000.0	0.2900	2899.99
1-26-16589	NT 7/32 STUD, PUSH		10000.0	0.0200	200.00
1-27-16590	GR BEARING BRONZE		20000.0	0.0800	1600.00
1-26-16591	SW 1/4 20x1 1/4 WING		20000.0	0.0300	600.00
2-22-16592	SU BEARING, INNER TUBE	B1477B2031	10000.0	3.2000	32000.00
2-40-16593	LL SUPPORT BAR ASSY-KEARNY PUM	S1477B4007-1	10000.0	0.0200	200.00
3-23-16724	PL PLATING & FINISHING		10000.0	0.8300	8300.00
2-40-16725	MN MANUAL & INSTRUCTIONS		10000.0	0.3500	3500.00
2-35-16726	PK PACKAGING		10000.0	2.0700	20699.99
				GRAND TOTAL $	515499.99

Figure 4-6 KEARNY PUMP COMPUTER PRINTOUT

Section 5

RECOMMENDATIONS

The following recommendations regarding shelter ventilation equipment are made as a consequence of the work and findings which were completed under Contract No. DCPA-78-C-0184.

ALTERNATE MATERIALS

While GARD was involved in the engineering study of the subject program, it became apparent that certain elements of the PVK and KPK kits, particularly the PVK support frame, could be substantially reduced in cost in a high volume procurement. The application of thermo-reinforced plastics and fiber composites appear to be promising alternate materials for the support frame. GARD recommends further effort in this and other related areas for a more economical ventilator.

DUCTING

The scrim polyethylene used on the KPK has potential application for the PVK ducting which deteriorates over extended periods of use. The scrim polyethylene is more durable and less resistant to tearing, but has a surface roughness that may result in some reduced air flow. A study and laboratory experiment should be performed to quantify the losses and judge the suitability of the material.

KPK

Operation of the Kearny pump initially seemed to be awkward to most operators during GARD's testing of the unit. Other novel methods of mixing and distributing shelter air should be investigated. Emphasis should be devoted to continuous flow rates, leg powered drive systems, and simplified

deployment. By suitable modification and sizing, the PVK may serve as an alternate.

PVK COMPUTER

Previously, any attempt at providing on-board computerization was unthinkable because of the costs involved. In 1969, a $5,000 unit would do what a simple $6 commercially-available, 4-bit microprocessor similar to Texas Instruments' TMS 1000 series does today. Such a device, for example, could be used in conjunction with an optical thumb sensor on the handle bars to measure pulse rate to tell the operator whether he is pedalling too fast or too slow, whether his level of exertion is detrimental to the operator's health, or calculate how much longer the operator can pedal. Further, blood pressures, fan speed, air flow and calories expended may also be determined. A study should be implemented to determine the possible uses of an on-board PVK computer, including recommended designs and costs.

COMPARATIVE TEST DATA

During the testing phase of this contract, it became apparent that some of the air flow tests could have been more sophisticated and that former data was lacking in certain areas. A more comprehensive test program of the current PVK would provide a sound comparative basis for future PVK's fabricated of other materials.

PVK FOR THE HANDICAPPED

The Federal government is placing more emphasis on accommodations for handicapped individuals (Ref: Rehabilitation Act of 1973). This focus on the handicapped has resulted in regulations affecting building design, sidewalk construction, etc. The current PVK requires the operator to pedal

with his/her feet. It may be possible to modify the PVK so that it may be operated by other methods.

PVK ANTHROPOMETRIC EVALUATIONS

The development of computer-aided design techniques has proven to be a great help in evaluating potential design. A computerized study can be done to determine what PVK design changes, if any, can be proposed to make the PVK suitable for people of many shapes and sizes. Similar anthropometric studies utilizing computer-aided design are currently being used by car manufacturers to assess the impact of changes in car designs on motorists.

TECHNOLOGY TRANSFER

Opportunities for using the pedal ventilator kit (PVK) may exist in government agencies other than the Defense Divil Preparedness Agency. A study should be made to determine where applications of the PVK are feasible. For example, the Department of Energy may benefit if the PVK can be used to generate an alternate source of energy.

REVISED BLAST WAVE EFFECTS TESTING

Significant changes in the materials used to fabricate the PVK would require, of course, certain testing to assure the integrity of the unit had not been compromised. Blast wave effects testing performed on earlier designs should also be included to determine the vulnerability of the new design.

The blast vulnerability testing performed in 1971 on existing designs indicated the PVK became inoperative at peak free field flow velocities of 200-300 ft/sec and overpressures greater than 5 psi. The tests were performed in a shock tunnel employing the volume detonation technique with primacord. As the primacord was detonated in a compression chamber, the pressure increased very rapidly and allowed to expand into an adjoining

test chamber, where the desired shock wave was generated. Various pressure measurements were taken as a function of time along with high speed motion pictures to obtain flow velocities.

Once an alternate material is selected for the PVK and prototypes fabricated, the blast vulnerability test should be repeated on the new design. Materials with a high strength-to-weight ratio will be expected to survive as well as the existing design.

FEM ANALYSIS

The Finite Element Method (FEM) is a computerized design and analysis technique developed originally for static analysis of frame type structures. A FEM Analysis of the PVK frame would allow for evaluation of alternate designs prior to full scale testing and production.

PVK/KPK - LARGE SCALE PROCUREMENT

Prior to any large scale procurement of the ventilator kits, it is recommended that applicable quality assurance and documentation control plans be formulated. The quality assurance plan should include as a minimum the definition of the following parameters.

- Special Gauges
- Fixtures
- Inspection Procedures
- Certification
- Specific Acceptance Criteria (Test Plan)
- Packing and shipping

The documentation control plan should include all the appropriate specifications necessary for efficient documentation flow, approval, and

control. As a minimum, the following procedures should be addressed.

- o ECR (Engineering Change Request)
- o ECR Review Procedure
- o Configuration Control Board
- o ECN (Engineering Change Notice)
- o ECN Implementation
- o Distribution of Revised Drawings
- o Documentation Control Center
- o Release Status Index Cards
- o Record of ECN's
- o Storage of Documents

Section 6

REFERENCES

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2. B. A. Libovicz and H. F. Behls, "Shelter Package Ventilation Kit", OCD Task Order No. 1423A, GARD Report 1244, General American Research Division, Niles, Illinois, October 1965.

3. S. J. Lis and H. F. Behls, "Ventilation Equipment Analysis for Basement Shelters:, OCD Task Order No. 1423A, GARD Report 1278, General American Research Division, Niles, Illinois, February 1968.

4. B. A. Libovicz, "Shelter Portable Ventilation Equipment", OCD Task Order No. 1423A, GARD Report 1430, General American Research Division, Niles, Illinois, January 1969.

5. A. L. Kapil, H. M. Sitko and J. M. Buday, "Ventilation Kits", OCD Work Unit 1423D, GARD Report 1477, General American Research Division, Niles, Illinois, November 1969.

6. H. Parker, "Mechanics and Strength of Materials", John Wiley & Sons, New York, N.Y.

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8. C. H. Kearny, "Instructions for Building a Homemade Large-Volume Shelter-Ventilating Punkah-Pump", Contract No. W-7405-eng-26, ORNL Report TM-1745, Oak Ridge National Laboratory, Oak Ridge, Tennessee, March 1967.

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Section 7

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GARD, INC., NILES, ILLINOIS

Development of Two Types of Ventilators
GARD Final Report 1703 - DCPA Work Unit 1423E
DCPA Contract No. DCPA01-78-C-0184
By Buday, J. M. and Klima, R. J.
April 1979 (UNCLASSIFIED) pp. 148

The objective of this program was to evaluate two types of ventilator kits for maximum cost effectiveness. The kits evaluated were the pedal ventilator and the Kearny pump. Both kits are designed to provide ventilation of designated fallout shelters. The subject units were previously developed by GARD, INC. in 1969 for DCPA under Contract No. DAHC20-68-C-0123. An engineering study was conducted on the ventilator kits to determine the potential manufacturing economies. Based on the conclusions of the study, the fabrication drawings, military specifications and deployment instructions were updated to reflect modifications determined to be cost-effective. Three prototype units of each kit were fabricated and assembled utilizing the revised documentation. One set of the ventilator kits was subsequently tested to assure that the units' performance and reliability were not compromised. Production cost estimates based on a procurement of 10,000 units each were generated for DCPA budgetary purposes.

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APPENDIX A

PEDAL VENTILATOR KIT

MILITARY SPECIFICATIONS

LIMITED COORDINATION

MILITARY SPECIFICATION

VENTILATOR KIT, PEDAL OPERATED (FAN TYPE, PVK)

This limited coordination military specification has been prepared by the Defense Civil Preparedness Agency based upon currently available technical information, but it has not been approved for promulgation as a coordinated military specification. It is subject to modification. However, pending its promulgation as a coordinated military specification, it may be used in procurement.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers the fabrication, assembly, performance, and packaging of a one-operator pedal-operated portable ventilation fan and removable plastic duct, for use in fallout shelters (see Figure 1).

1.2 Classification. Pedal-operated ventilator kits shall be of one type.

Type 1 - One-operator pedal ventilator kit.

2. APPLICABLE SPECIFICATIONS, STANDARDS, DRAWINGS AND OTHER PUBLICATIONS

2.1 Specifications and Standards. The following specifications and standards of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

GGG-S-278	Shears And Scissors
L-P-378a	Plastic Film (Polyethylene Thin Gage)
MMM-A-250	Adhesive, Water-resistant, (For Sealing Fiberboard Boxes)
PPP-B-636H	Box, Fiberboard
PPP-B-1163	Box, Corrugated Fiberboard, High Compression Strength, Weather-resistant, Wax-resin Impregnated
PPP-T-45	Tape, Gummed, Paper, Reinforced And Plain, For Sealing And Securing
PPP-T-60	Tape, Pressure-sensitive Adhesive, Waterproof, For Packaging
PPP-T-76	Tape, Pressure-sensitive Adhesive Paper, Water Resistant, (For Carton Sealing)

Federal

QQ-Z-325C	Zinc Coating, Electrodeposited, Requirements For
TT-E-529C	Enamel, Alkyd, Semi-gloss

Military

MIL-B-131	Barrier Material, Water Vaporproof, Flexible
MIL-C-5541	Chemicals Films And Chemical Film Materials For Aluminum And Aluminum Alloys
MIL-P-116	Preservation, Methods Of

STANDARDS

Federal

FED.STD.NO.595	Colors

Military

MIL-STD-105D	Sampling Procedures and Tables For Inspection By Attributes
MIL-STD-129F	Marking For Shipment And Storage
MIL-STD-171C	Finishing Of Metal And Wood Surfaces

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge at the General Services Administration Regional Offices in Boston, New York, Atlanta, Chicago, Kansas City, Mo.; Dallas, Denver, San Francisco, Los Angeles, Seattle and Washington, D.C. Copies of the military specifications and standards required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

2.2 Drawings. One-operator Pedal Ventilator Kit, 30-Inch Fan.

1477J6000	One-operator Pedal Ventilator Assy
E6010	Frame Assy
C6011	Leg, Front Support
B6012	Leg, Rear Support
B6013	Bar, Rear Support
B6014	Foot, Support
B6015	Hanger, Crank
B6017	Stem, Saddle Support
C6018	Handle Bar Assy

1477C6019	Sprocket, Drive
B6020	Sprocket, Fan Shaft
B6021	Shaft, Fan
D6022	Shroud, Fan
D6023	Guard, Fan
A6024	Wood Lattice, Packing Box
B6026	Decals

2.3 Other Publications. The following publications, of the issue in effect on date of invitation for bids, form a part of this specification:

Air Moving and Conditioning Association, Inc.

Publication: AMCA Standard 210
Test Code for Air Moving Devices

(Copies of AMCA publications may be obtained from the Air Moving and Conditioning Association, Inc., 30 West University Drive, Arlington Heights, Illinois 60004.)

3. REQUIREMENTS

3.1 Drawings. Unless otherwise specified herein, the materials and assembly thereof shall be as shown on the drawings (see 2.2); however, minor changes will be allowed. Any minor change or substitution of materials must not affect the rigidity of the unit and the performance requirements specified herein and must be approved by the contracting officer. Drawings are furnished for contractor guidance and informational purposes only to illustrate details of the required equipment. While every precaution has been taken to assure their accuracy, the contractor is responsible for dimensional adequacy and accurate fits for proper equipment assembly, alignment, and operation.

3.1.1 Contents of a Complete One-operator Pedal Ventilator Kit shall be as follows:

(a) One-operator pedal ventilator, complete
(b) PVK instruction booklet, three copies
(c) Duct, polyethylene, one roll, 30-inch diameter by 50 feet long by 4 mil thick
(d) Tape, duct, pressure-sensitive, one roll, 2 inches wide by 30 yards long
(e) Lubricant, SAE20 oil, 1-1/2 ounces
(f) Scissors, one pair, 4-inch

3.1.2 Metal Fabrication. Metal used in the fabrication of the equipment shall be free from kinks. The straightening of material shall be done by methods that will not cause injury to the metal. Shearing and chipping shall be done neatly and accurately. Corners shall be square and true.

3.1.3 Machine Work. Tolerance and gages for metal fits shall conform to the limitations specified herein and otherwise to the standards of best commercial practice. Finished contact and bearing surfaces shall be true and exact. Adequate gages shall be utilized to assure proper joint fit, interchangeability, alignment, chain tension, and fan concentricity with respect to the shroud.

3.1.4 Bolted Connections. Bolt holes shall be accurately punched or drilled and shall have the burrs removed. All bolts, screws and nuts shall be tight.

3.1.5 Welding. The surfaces of parts to be welded shall be free from rust, scale, paint, grease and other foreign matter. Welds shall develop adequate strength in the parts connected.

3.1.6 Heat Treatment. As specified on drawings.

3.1.7 Painting and Finishing. Major units and subassemblies shall be painted or finished as specified herein or on drawings.

3.2 Fan. The fan diameter shall be 30.00 $\pm$ 0.05 inches, the leading and trailing edges shall be in line within 0.11 inches and shall be statically balanced within 0.16 ounce-inches. The fan rotation shall be clockwise (facing air discharge), and the leading edge shall be from 1/8 to 1/4 inch from the air discharge side of the shroud such that the fan does not project beyond the shroud. The fan shall be equal to and interchangeable with the Torin Manufacturing Co., fan number R-3020-4. Any substitution shall meet or exceed performance requirements stated in Figure 2.

3.3 Transmission. The ratio of fan shaft speed to pedal speed shall be approximately 7.7/1. The chain shall be American Standards Association No. 35. All chains shall be endless riveted.

3.4 Saddle. The seat shall have full three point spring suspension, and shall be a minimum of 9 inches long and 9-3/4 inches wide. The top shall be vinyl covered, rubber padded. The seat clamp shall be 7/8 inch dia. and the nut shall be hexagon, 9/16 across the flats. The saddle shall be finished by the standard methods of the manufacturer.

3.5 Accessories.

3.5.1 PVK Instruction Booklet. Each ventilation kit shall include three copies of the PVK instruction booklet. This publication will be furnished by the Defense Civil Preparedness Agency at the time of the contract award.

3.5.2 Duct, Polyethylene. One roll polyethylene duct, 30-inch diameter by 50 feet long by 4 mil thick with a flat dimension of 48 inches conforming to Type II, Grade C, Finish 1 of L-P-378 shall be supplied with each ventilator unit.

3.5.3 Tape, Duct. One roll of pressure-sensitive duct tape, 2 inches wide by 30 yards long shall be furnished with each kit. The duct tape shall conform to PPP-T-60, Type III, Class 1, such as gray color Arno brand or equivalent.

3.5.4 Lubricant. One and one-half (1-1/2) ounces of SAE20 lube oil in a clear plastic container shall be furnished with each kit. The container shall be approximately 1 inch by 4-5/8 inches, and shall have a blind dispenser tip head.

3.5.5 Scissors. Contractor will furnish one 4-inch, blunt point scissors with each kit. Scissors shall be in accordance with GGG-S-278, Type II, Class 3, Style A and/or Style B, Size 4.

3.6 Lubrication at Assembly. The crank bearings shall be permanently lubricated with a lubricant formulated with a non-soap, organic-type thickener (di-amide-carbonyl) such as American Oil Company "RYKON" Grease No. 2. The grease shall be suitable for long shelf life stability without further lubrication during use.

3.7 Finish and Color. All parts shall be free from burrs, roughness, and rust. The subassemblies and assemblies, where a painted finish is required, shall be finished as follows unless other wise noted herein or on the drawings:

Cleaning - Finish 4.2 of MIL-STD-171.
Surface Treatment - Finish 5.3.1.3 of MIL-STD-171.
Prime - Finish 5.2 of MIL-STD-171.
Finish - One coat, semi-gloss white untinted, No. 27875 of FED. STD. No. 595, enamel, alkyd certified to equal or exceed the performance requirements of TT-E-529.

The drive sprocket, fan shaft sprocket, fan shaft and fan guard shall be finished as follows:

Zinc plate per QQ-Z-325, Class 2, Type II with clear chromate treatment.

3.8 Marking. Specific markings on the pedal ventilator shall be made by decalcomanias applied per instructions on the decal prints.

3.9 Workmanship. All materials used in the unit shall be of good commercial quality, entirely suitable for the purpose intended. The units, including all accessories, shall be constructed and finished in a thoroughly workmanlike manner. Particular attention shall be given to neatness and thoroughness of machining, fitting of parts, welding, riveting and marking of assemblies. Visual defects shall be cause for rejection.

3.10 Preproduction Sample. When specified in the contract or order (see 6.2) before production is commenced, a sample kit shall be submitted or made available to the contracting officer or his authorized representative for approval in accordance with 4.2. The approval of the preproduction sample authorizes the commencement of production, but does not relieve the supplier of responsibility for compliance with all applicable provisions of this specification. The preproduction sample shall be manufactured in the same facilities to be used for the manufacture of the production items.

4. QUALITY ASSURANCE PROVISIONS

4.1 Inspection Responsibility. The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Preproduction Sample Inspection. When a preproduction sample is required, it shall be examined in accordance with applicable paragraphs of Section 3 and Section 4 (with laboratory tests at the contractor's expense). A two-week endurance test shall be required for the fan and transmission used in the preproduction model, if these components are different than the prototype components suggested for use in 3.2 or on drawing 1477J6000.

4.3 Production Inspection.

4.3.1 Performance. The inspector shall ascertain that the units meet the performance requirements specified herein.

4.3.2 Workmanship. The units shall be inspected for rigidity, chain tension, alignment, interference of components, finish, color (see 3.7) and marking (see 3.8).

4.3.3 Packing and Marking. The inspector shall ascertain that the packing and marking of the containers conform to this specification.

4.4 Tests. If there is any change or substitution in the fan-shroud assembly, or transmission, other than the prototype components suggested for use in 3.2 or on Drawing 1477J6000, then performance tests for these items shall be required.

4.4.1 Fan Assembly Performance, The fan-shroud assembly shall be tested per AMCA Standard 210 at 480 RPM and shall have the performance characteristics shown in Figure 2.

4.4.2 Packaging. Cleanliness, leakage, and heat seal tests are required per MIL-P-116, Table 3.

4.5 Quality Conformance Inspection.

4.5.1 Lot. A lot shall consist of one day's production or all units offered for acceptance at one time.

4.5.2 Sampling.

4.5.2.1 Sampling for Examination. Sampling for examination shall be in accordance with MIL-STD-105. For major defects the AQL shall be 2.5 percent defective units, at inspection Level II. For minor defects, the AQL shall be 6.5 percent at inspection Level I (or S_2 for standards parts). Each minor characteristic shall be considered separately for acceptance of the lot.

4.5.2.2 Sampling for Tests. Sampling for tests shall be in accordance with MIL-STD-105 at inspection Level II. The AQL shall be 1.0 percent defective.

4.5.3 Examination. Each unit selected in accordance with 4.5.2.1 shall be examined for defects listed in Table I. Any sample having one or more defects shall be considered a defective unit.

Table I

CLASSIFICATION OF DEFECTS

Category		Defect
Major		
	101	Packaging not acceptable; equipment could be damaged or small parts lost.
	102	Package marking not as specified.
	103	Welds not acceptable.
	104	Chain too tight; will not fit sprockets.
	105	Components or hardware - including PVK instruction booklets - missing.
	106	Handle bar will not fit in front support leg.
	107	Incorrect number of teeth in the sprockets.
	108	Material not as specified.
	109	Dimensions not as specified.
	110	Metal fabrication not suitable.
	111	Workmanship not acceptable.
	112	Finish not as specified or acceptable.
	113	Drive chain too loose.
Minor		None

4.5.4 Function Tests. Samples selected in accordance with 4.5.2.2 shall be tested as specified herein. Any sample failing to pass any test shall be considered a defective unit.

4.5.4.1 Operate the ventilator at the normal pedaling rate of 55 RPM. Check for the following defects:

(a) Chain too loose.
(b) Sprockets out of line.
(c) Fan hitting the shroud.
(d) Fan hitting the fan guard.
(e) Loose parts.
(f) Bearings too loose.
(g) Bearings too tight.

4.6 Inspection of Preparation for Delivery. The contents, preservation, packing, and marking shall be inspected to determine compliance with the requirements of Section 5 of this specification.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging of the pedal ventilator and accessories (see 3.1.1).

5.1.1 The following preservation procedures in conformance with MIL-P-116 shall be effected.

5.1.1.1 *Duct. The polyethylene duct shall* be wound on a core with an approximate outside diameter of 3 inches and approximately 48-1/4 inches in length. The duct shall be suitably restrained from unwinding with masking tape.

5.1.1.1.1 Duct, Packaging. The roll of duct shall be packed in a Style FPF, Type CF, Class Domestic, Variety SW, Grade 125 box fabricated and closed in conformance with PPP-B-636. Approximate inside dimensions shall be 48-1/2 inches long by 4-3/8 inches wide by 4-3/8 inches deep. The box shall be closed with gummed paper tape 2 inches wide conforming to PPP-T-45. The contents of the box will be marked (3/4 inch letters) on one panel of the box (see 5.2.1).

5.1.1.2 Tape, Duct. The roll of duct tape (see 3.5.3) shall be packaged in conformance with method IA-8 of MIL-P-116.

5.1.1.3 Oil. The lubricating oil in the clear plastic container (see 3.5.4) shall be packaged in conformance with method IC-3 of MIL-P-116.

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DEVELOPMENT OF TWO TYPES OF VENTILATORS.(U)
APR 79 J M BUDAY, R J KLIMA DCPA01-78-C-0184
UNCLASSIFIED GARD-1703 NL

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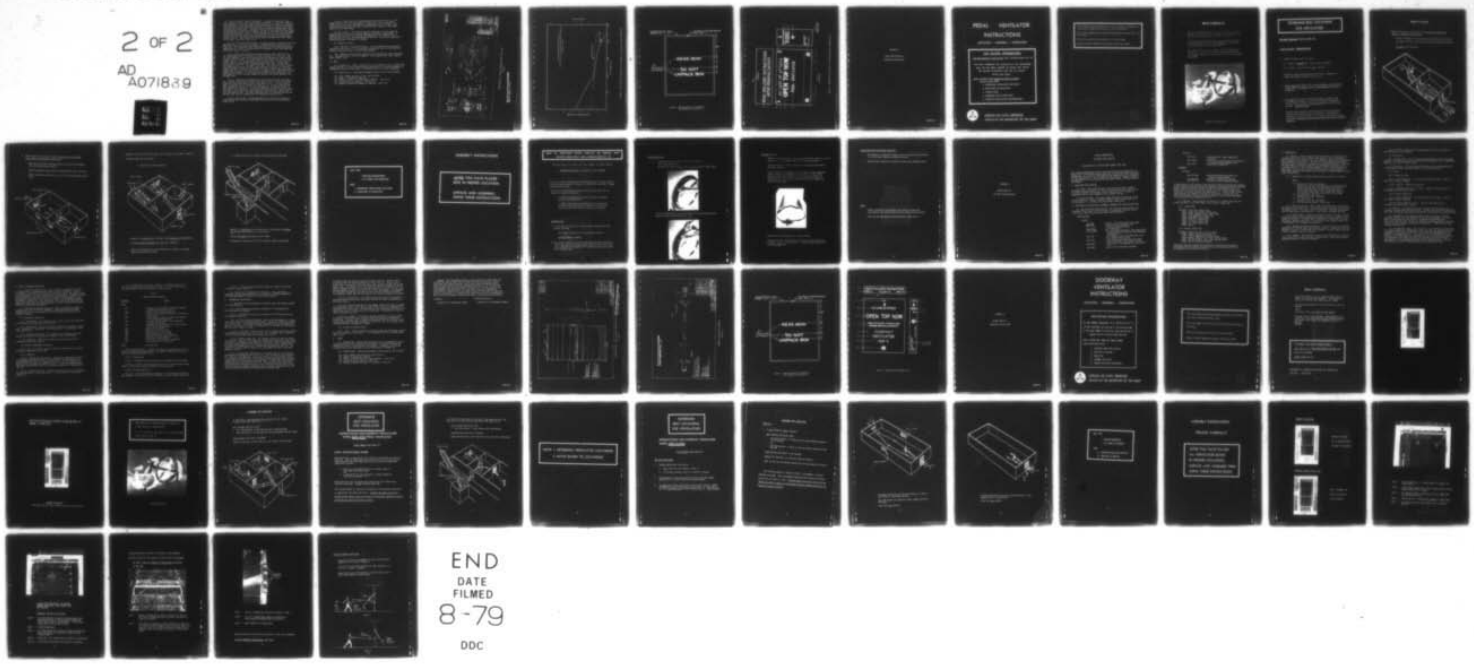

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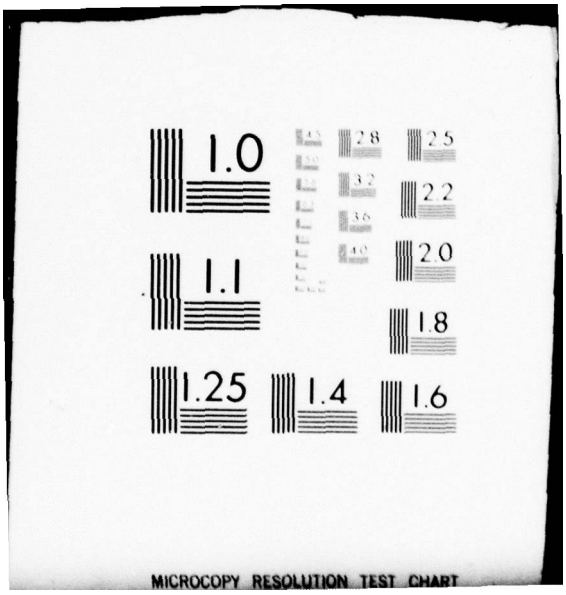
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MICROCOPY RESOLUTION TEST CHART

5.1.1.4 Packing of Small Accessories. The small accessories, duct tape, lubricating oil, and scissors shall be packed in a Style RSC, Type CF, Class Domestic, Variety SW, Grade 125 box fabricated to commercial standards. The approximate inside dimensions shall be 6-1/2 inches long by 6-1/2 inches wide and 3-1/2 inches deep. The box shall be closed with gummed paper tape. The packing order shall be as follows: The roll of duct tape shall be placed in the box and covered with a fiberboard divider 6-3/8 inches by 6-3/8 inches of the same material as the box. On the divider the packets containing the scissors and lubricating oil shall be placed and the box closed with tape (see 5.1.1.1.1). The contents of the box shall be marked (1/2 inch letters) on one panel of the box (see 5.2.1).

5.1.1.5 PVK Instruction Booklet. The three copies of the PVK instruction booklets (see 3.5.1) shall be packaged in conformance with method IC-3 of MIL-P-116. The transparent heat sealed bag shall be fabricated from material conforming to L-P-378. The message and its placement on the waterproof bag shall be as shown in Figure 3.

5.1.2 Interior Box Containing the One-operator Pedal Ventilator Kit. The one-operator pedal ventilator kit shall be packed in a Style FOL, Type CF, Class Domestic, variety SW, Grade 200 box fabricated and closed in conformance with PPP-B-636. The approximate inside dimensions shall be 59-1/4 inches long by 17-1/4 inches wide by 37-1/4 inches deep. The top flaps of the box shall be closed with reinforced gummed paper tape 3 inches wide conforming to PPP-T-45. The bottom flaps shall be closed with metal staples. The inside bottom of the box shall have a wooden lattice of 1/4 inch thick lumber inserted on which the ventilator will stand. Additional cushioning padding and inner packing forms shall be included as may be needed to suitably protect the equipment. The wood lattice and inner packing forms shall be fabricated to reflect the best commercial practice to prevent damage to the packaged item.

5.1.2.1 Interior Box Packaging for the One-operator Pedal Ventilator Kit. The box containing the plastic duct (see 5.1.1.1.1) shall be securely taped with reinforced plastic tape to the wood lattice. The wood lattice shall be placed into the interior box (see 5.1.2). The box containing the small accessories (see 5.1.1.4) shall be taped with reinforced plastic to the frame of the ventilator. The packet containing the PVK instruction booklets (see 5.1.1.5) shall be taped securely to the ventilator saddle with 1 inch wide masking tape. The pedal ventilator shall be inserted into the box and any inner forms or padding shall be installed around the unit.

5.1.2.2 Barrier Bag. The packed interior box shall be enclosed in a close fitting heat sealed bag fabricated from barrier material conforming to MIL-B-131.

5.1.2.3 Exterior Box for the One-operator Pedal Ventilator Kit. The bagged interior box shall be packed in a Style OSC, Class I, Type SWCFI, Grade 275 box, wax-resin impregnated in conformance with PPP-B-1163. The approximate inside dimensions shall be 59-3/4 inches long by 17-3/4 inches wide by 37-3/4 inches deep.

5.1.2.4 Closure. The flaps of the box specified in 5.1.2.3 shall be securely sealed with water resistant adhesive conforming to MMM-A-250. In addition the seam shall be sealed by the application of a minimum 3 inch wide pressure-sensitive tape conforming to PPP-T-76. The strip of tape shall overlap each panel a minimum of 6 inches.

5.2 Marking of Boxes.

5.2.1 Marking of Intermediate Boxes. The intermediate boxes containing the plastic duct (see 5.1.1.1.1) and small accessories (see 5.1.1.4) shall be marked on one panel with a listing of the contents.

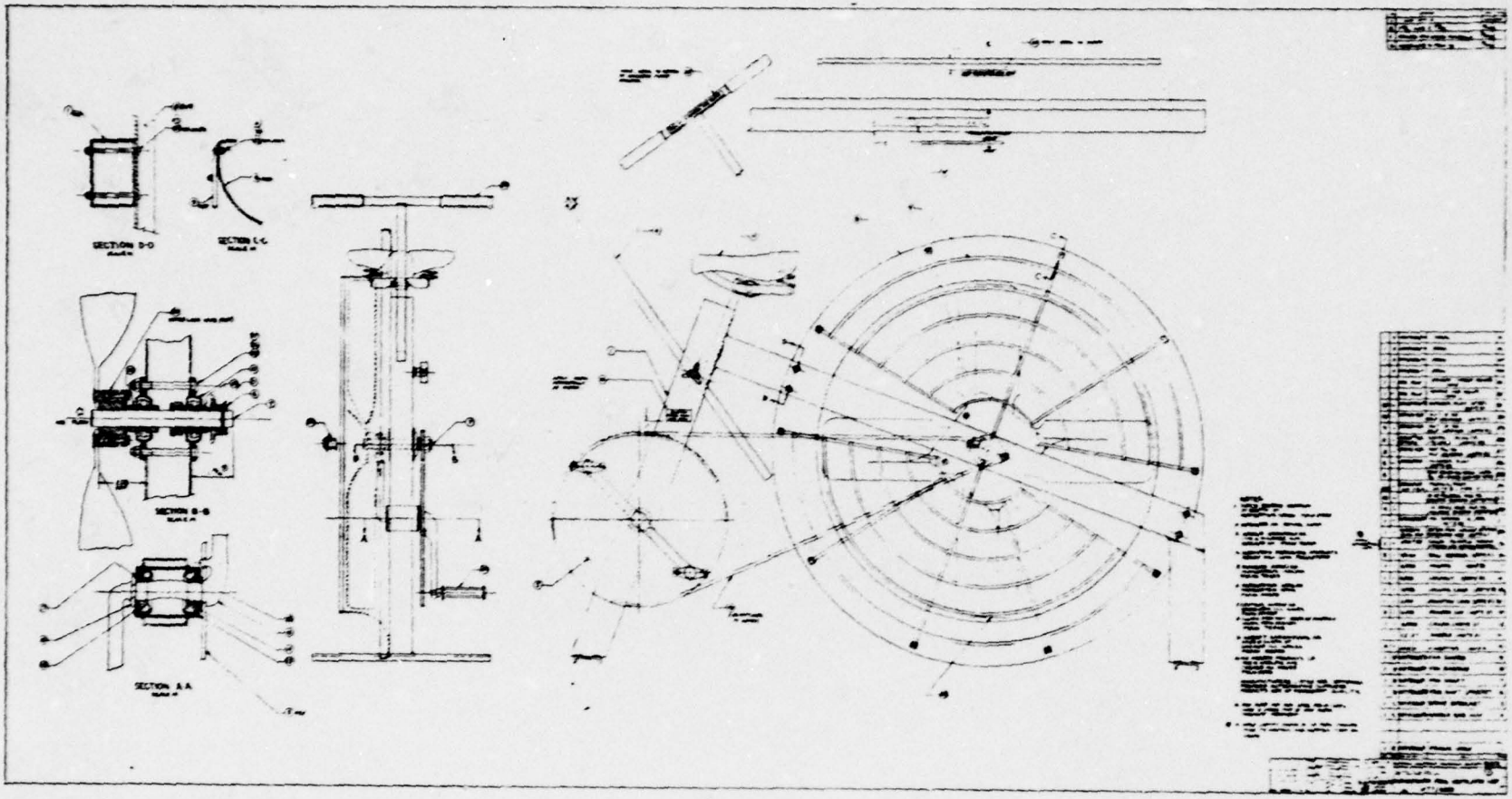
5.2.2 Marking of Exterior Box Containing the One-Operator Pedal Ventilator Kit. The marking shall be as per Figure 4. The lettering shall be in yellow and in Gothic style.

6. NOTES

6.1 Intended Use. Pedal ventilator kits are intended for use in identified fallout shelters to provide the necessary ventilation air to maintain thermal and atmospheric control of the shelter's environment during a national emergency.

6.2 Ordering Data. Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Number of assemblies required.
(c) Contact point for PVK instruction booklets. (See 3.5.1)
(d) Listing of serial numbers. (See 5.2.2)
(e) Whether preproduction sample is required. (See 3.10)



VENTILATOR KIT, PEDAL OPERATED (FAN TYPE, PVK)

Figure 1

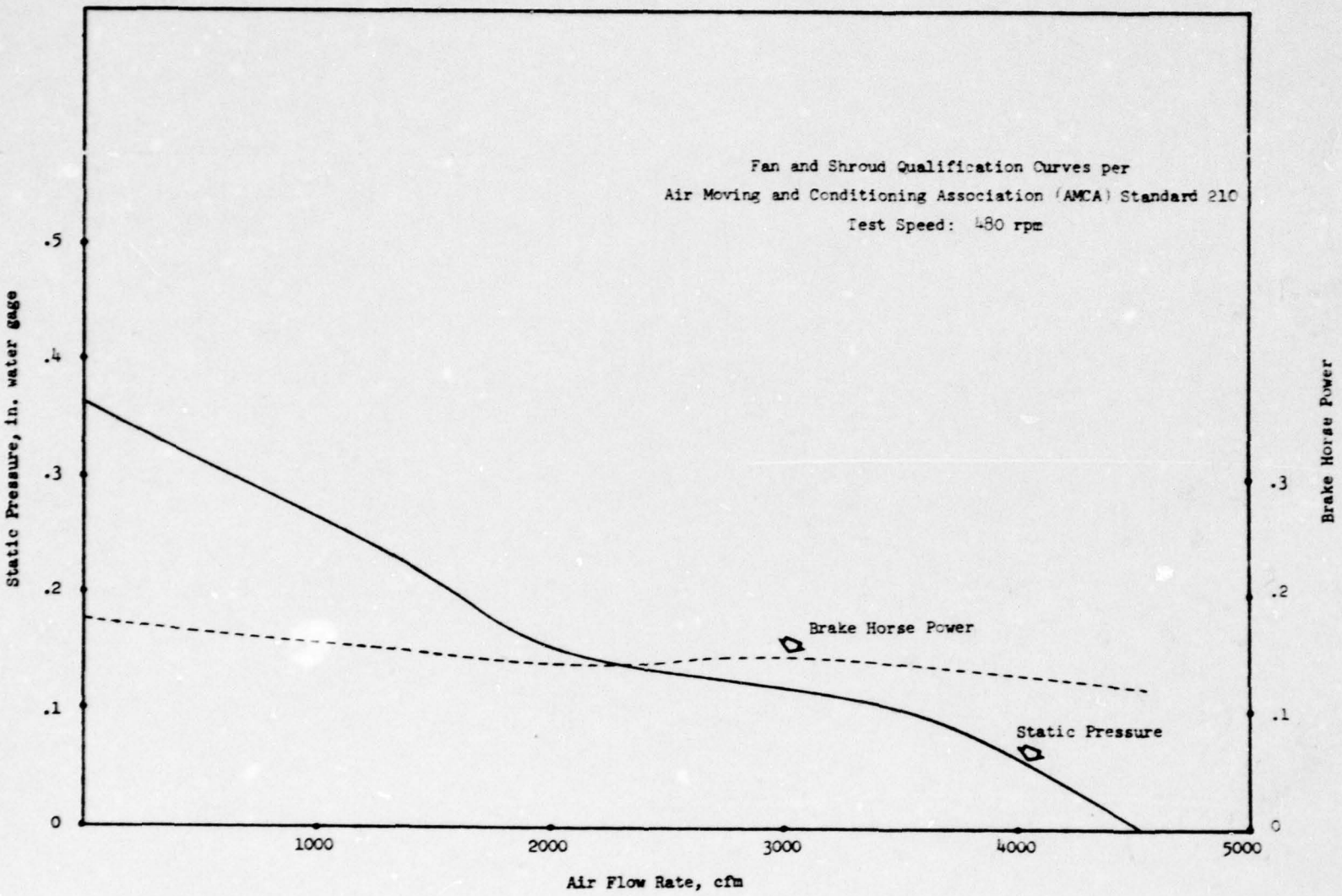


Figure 2 FAN AND SHROUD QUALIFICATION CURVES. ONE-OPERATOR PEDAL VENTILATOR

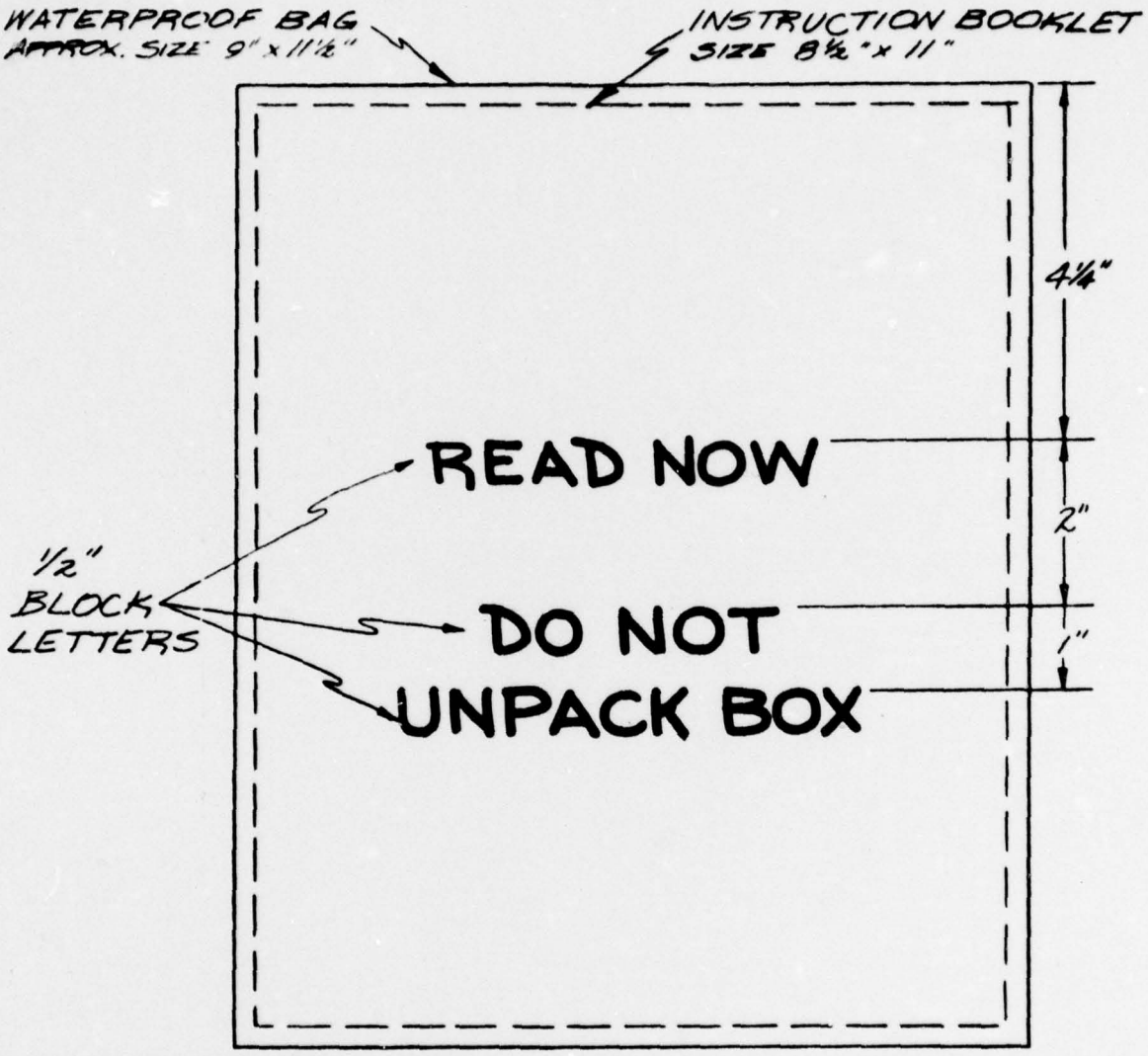


Figure 3 MESSAGE MARKING ON WATERPROOF
PVK INSTRUCTION BOOKLET BAG

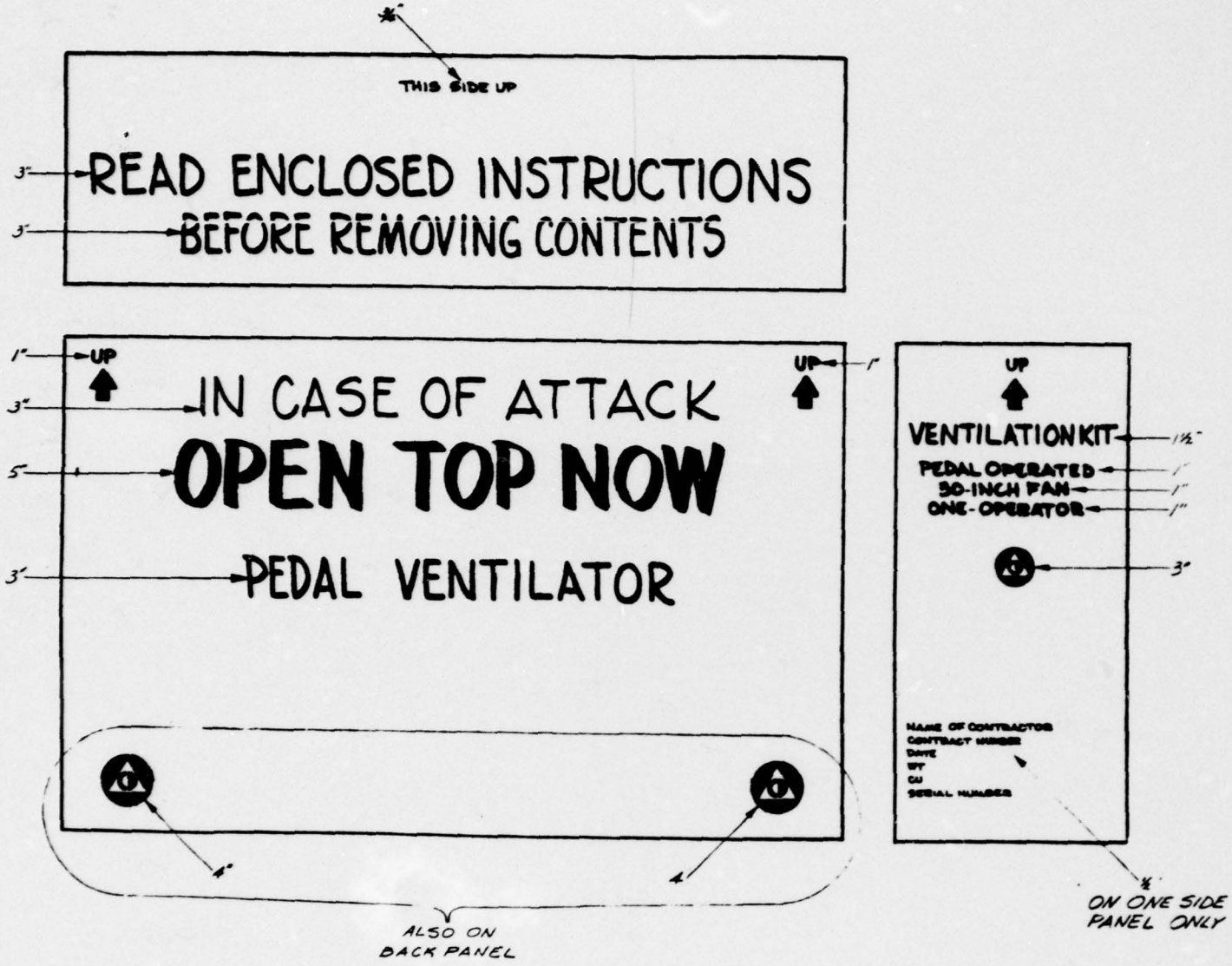


Figure 4 EXTERIOR BOX MARKINGS, ONE-OPERATOR PEDAL VENTILATOR KIT

APPENDIX B

PEDAL VENTILATOR KIT

OPERATING INSTRUCTIONS

PEDAL VENTILATOR INSTRUCTIONS

LOCATION — ASSEMBLY — OPERATION

LIFE SAVING INFORMATION

DO NOT UNPACK VENTILATOR UNTIL INSTRUCTIONS SAY TO

YOU MUST DETERMINE THE LOCATION OF THE VENTILATORS NOW, OR THE GREAT NUMBER OF PEOPLE MAY CAUSE THE SHELTER TO BECOME TOO HOT TO OCCUPY WITHIN ONE HOUR.

READ INSTRUCTIONS PAGE BY PAGE AT ONCE !
FOLLOW THESE STEPS:

1. DETERMINE VENTILATOR LOCATION
2. MOVE BOX TO LOCATION
3. UNPACK BOX
4. ASSEMBLE VENTILATOR DUCT
5. OPERATE VENTILATOR CONTINUOUSLY

OFFICE OF CIVIL DEFENSE
OFFICE OF THE SECRETARY OF THE ARMY

The THREE people holding these Pedal Ventilator Instructions should work together as a team to set up ventilation.

Each team member must read the instructions now and follow all directions.

Decide any questions by talking it over and voting.

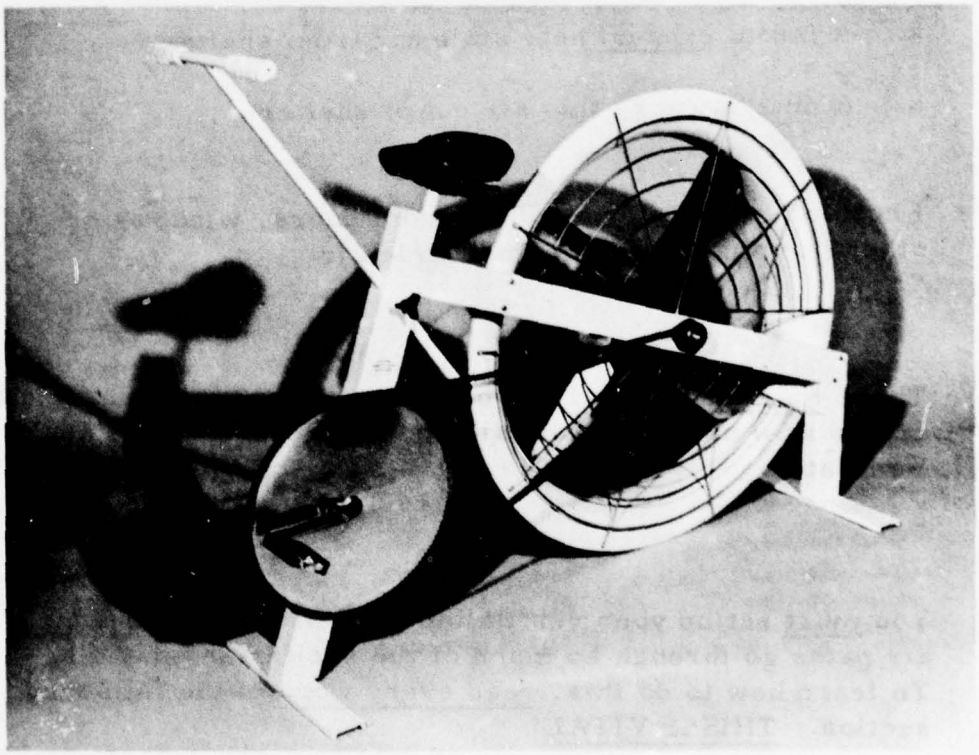
Should a Shelter Manager be present, follow his orders.

READ CAREFULLY!

- The fallout shelter you are in, may have one room or a number of rooms and areas together. You may have to stay in this shelter for several days or longer.

- Use the Pedal Ventilator (shown below) and the plastic exhaust duct (packed with it) to remove hot, stale air from shelter so fresh air can enter.

- Incoming, fresh air will be safe! After Ventilator is operating, if you are uncertain about radiation effects and shelter ventilation, use appendices at back of booklet. NOT NOW!



PEDAL VENTILATOR

DETERMINE BEST LOCATIONS FOR VENTILATORS

DO NOT UNPACK VENTILATOR YET

LOCATION PRINCIPLES

1. Pedal Ventilator has two parts:

   a. A fan to exhaust hot, stale air from shelter,

   b. A duct to carry this air out of shelter.

   Fresh air then enters shelter from doors, windows or other openings to replace hot, stale air.

2. There must be at least one outside opening so fresh air can create flow paths from outside opening(s) to fan of Pedal Ventilator.

3. You must set up your ventilation system to make fresh air paths go through as much of the shelter as possible. To learn how to do this, read every word of the following section. THIS IS VITAL!

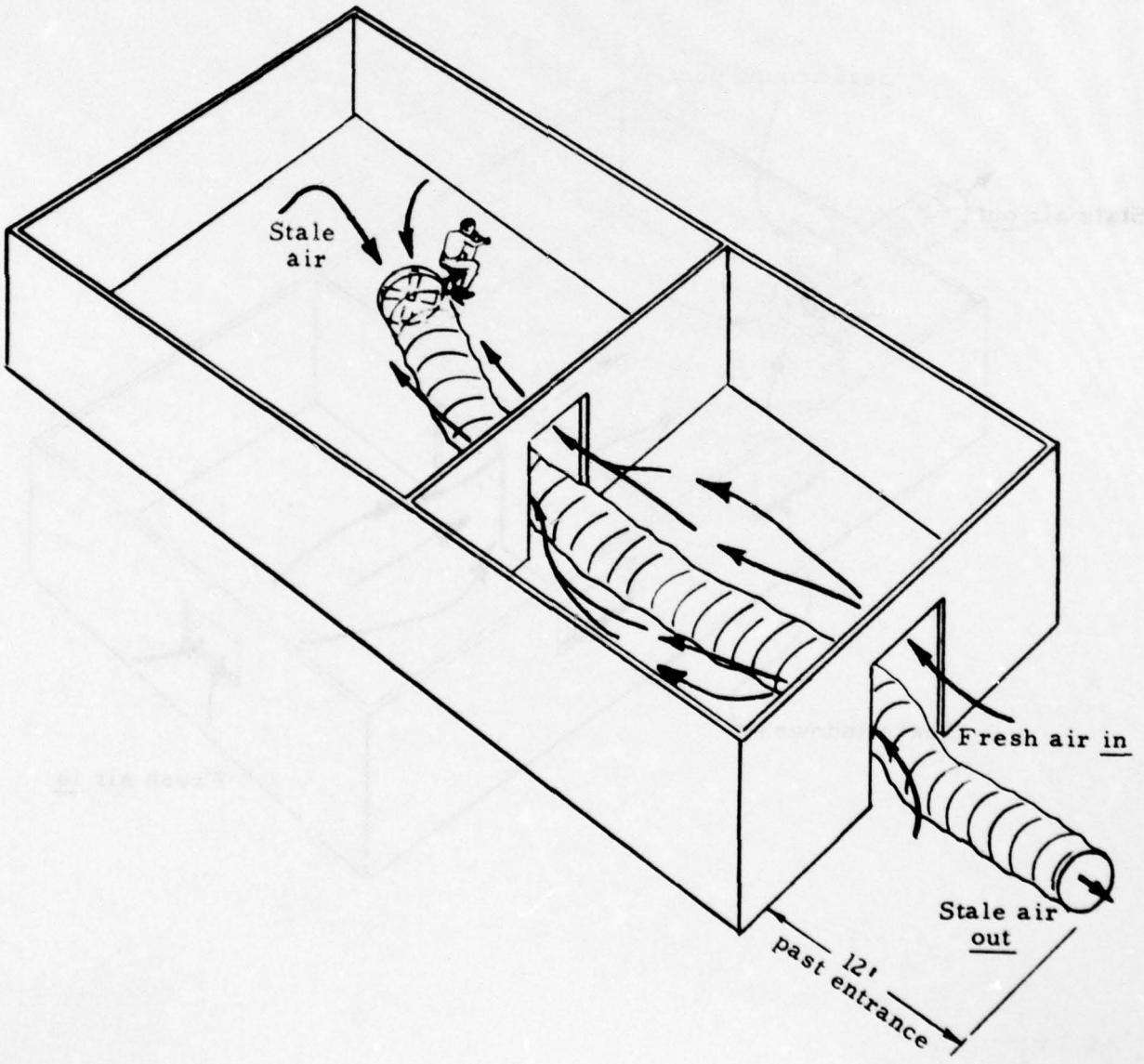
   The following models of shelters show how to locate the Ventilator in different types of shelters. Although the models may not be similar to the shelter you are in, each illustrates important location principles and should be studied carefully.

WHERE TO LOCATE

1. When Ventilator is placed inside a shelter or room with only one opening to outside air:

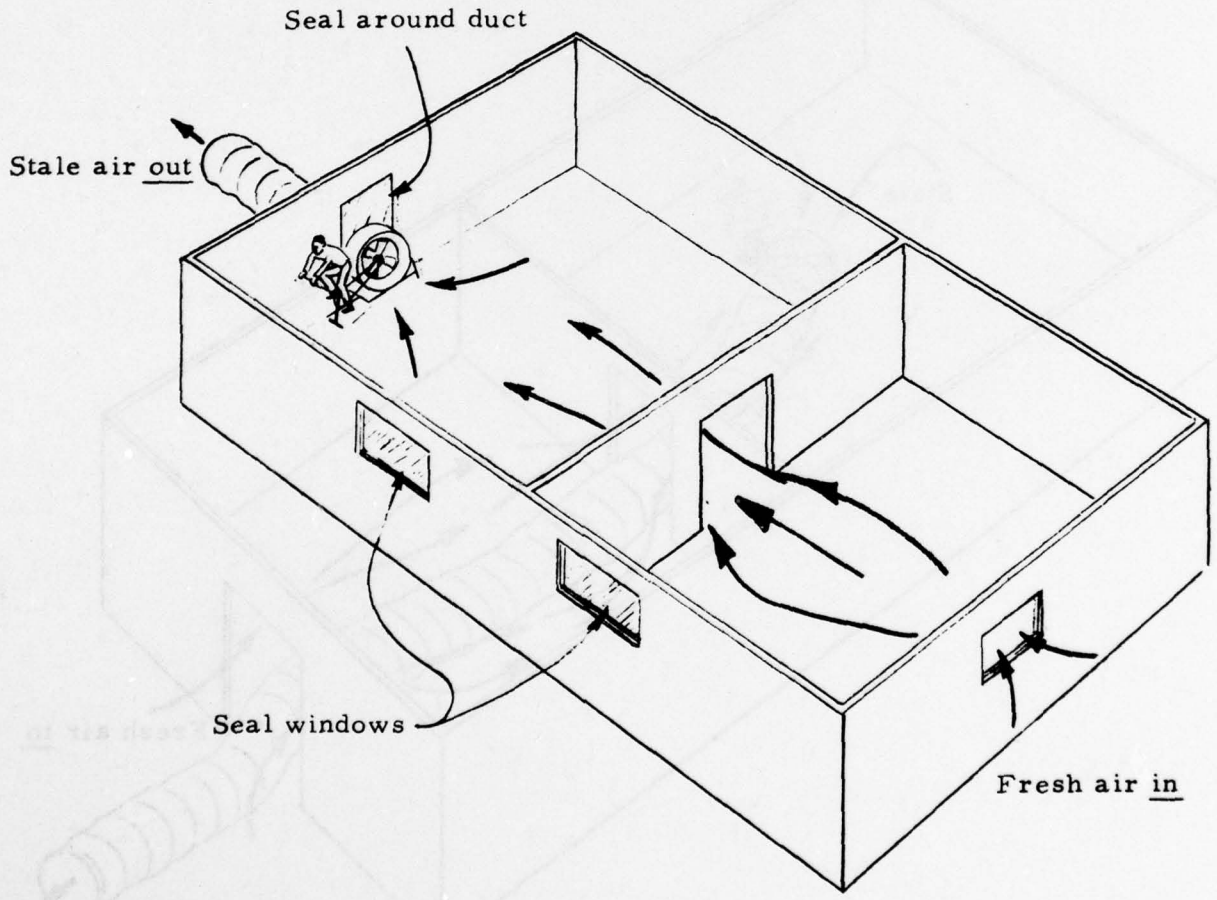
   - Place Ventilator as far from outside opening as possible, as long as 12 feet of duct can extend past shelter entrance.

   - DO NOT seal openings.



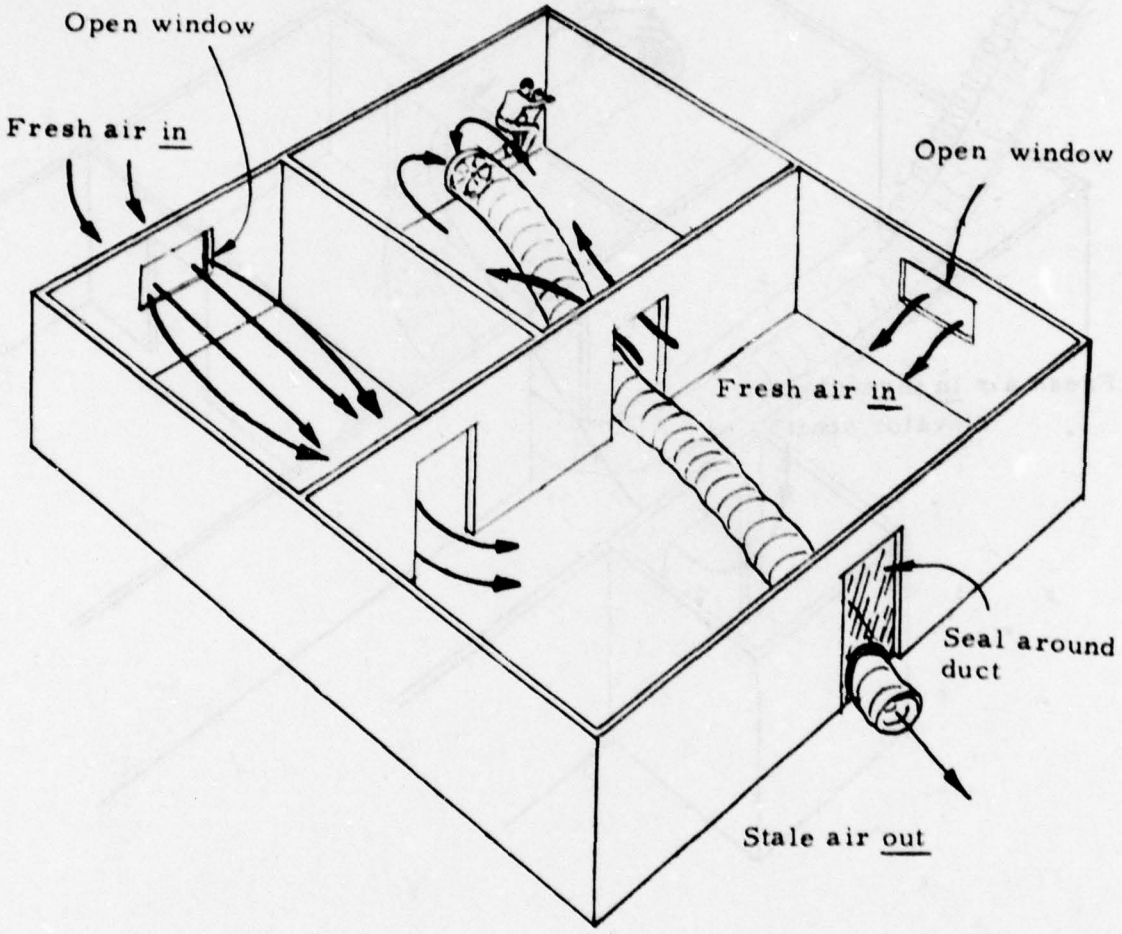
2. When Ventilator is placed inside a shelter or room with more than one opening to outside air:

- Seal all but the two openings which will form the longest air flow path between them,
- Place Ventilator right next to opening where duct will exit,
- After Ventilator and duct are in place, seal opening around duct.



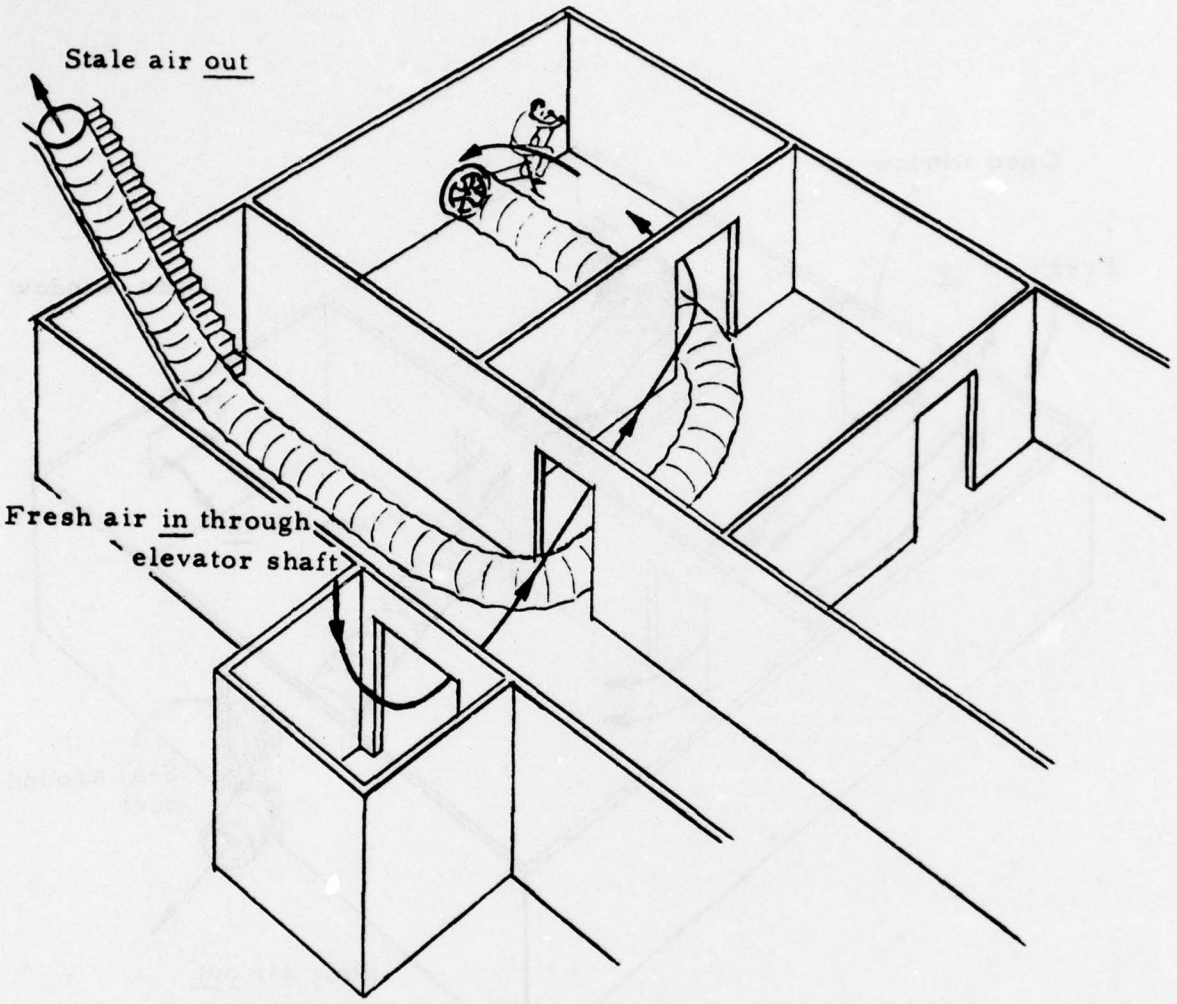
Models 3 and 4 show how to apply the principles of models 1 and 2 to shelters with several rooms.

3. Shelter with Three Rooms



- Stale air is pulled in by Ventilator and blown out through duct.
- Fresh air enters shelter through open windows.
- Note seal around duct, and Ventilator in corner, to create longest possible flow path.

4. Basement Shelter without Direct Opening to Outside



- Stale air is pulled in from basement by Ventilator and blown out through duct which is run up stairs.
- Fresh air enters through elevator shaft.
- Ventilator is placed as far from elevator shaft as possible.

NOW, FIND

— SHELTER BOUNDARIES

— ALL FRESH AIR OPENINGS

THEN:

1. DETERMINE VENTILATOR LOCATION
2. MOVE BOX TO LOCATION

ASSEMBLY INSTRUCTIONS

AFTER YOU HAVE PLACED BOX IN PROPER LOCATION,

UNPACK AND ASSEMBLE, USING THESE INSTRUCTIONS

READ ALL DIRECTIONS BEFORE WORKING ON EXHAUST DUCT

DO NOT UNROLL DUCT UNTIL INSTRUCTIONS SAY TO.

DO NOT WALK ON DUCT AT ANY TIME. IT WILL RIP!!

NEVER HANG DUCT, LEAVE IT ON FLOOR

Duct must run from Pedal Ventilator to outside of entire shelter area (through a window, doorway or other large opening). Avoid sharp bends in duct!

If an attack has already occurred and you think that there is radiation outside the shelter:

> Consult with radiation monitor or shelter manager before leaving shelter.
>
> If there is no advice available about radiation and you must leave the shelter, then leave it only for short periods and return as quickly as possible.

REMEMBER:

1. If fresh air comes in from same outside opening that duct passes through,

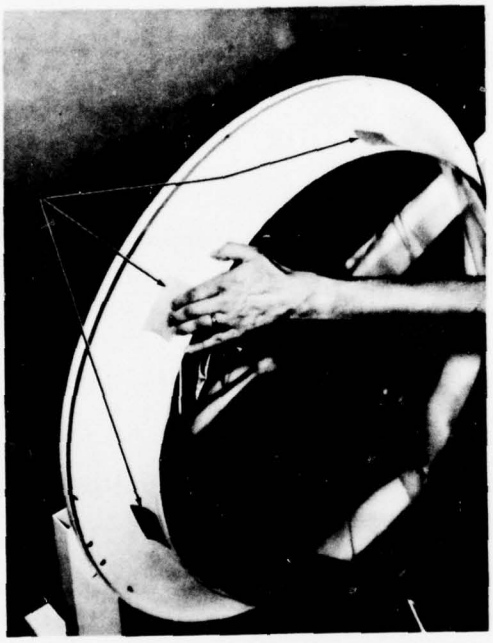
   Duct must extend 12 feet past outside opening.

   DO NOT SEAL opening.

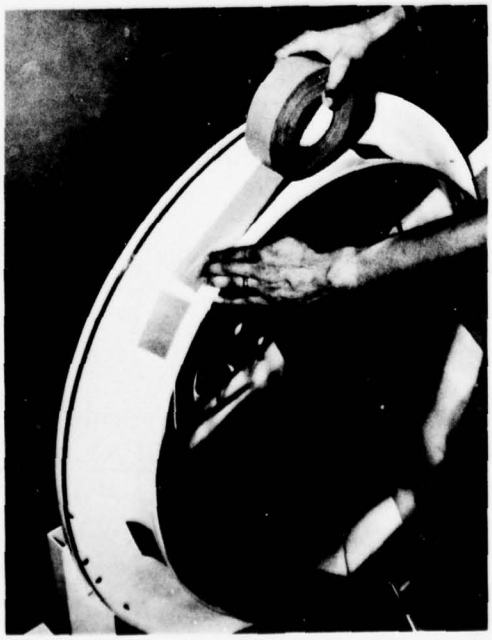
2. If fresh air comes in from outside opening other than those which duct passes through, SEAL opening around duct, and other openings as necessary. It is not necessary to extend duct beyond a seal.

Connecting Duct

- Unroll a few feet of duct and stretch end of duct around fan ring.
- Secure duct end in place with several pieces of duct tape.



- Form complete duct-ring attachment by unrolling and securing duct tape around entire fan ring.

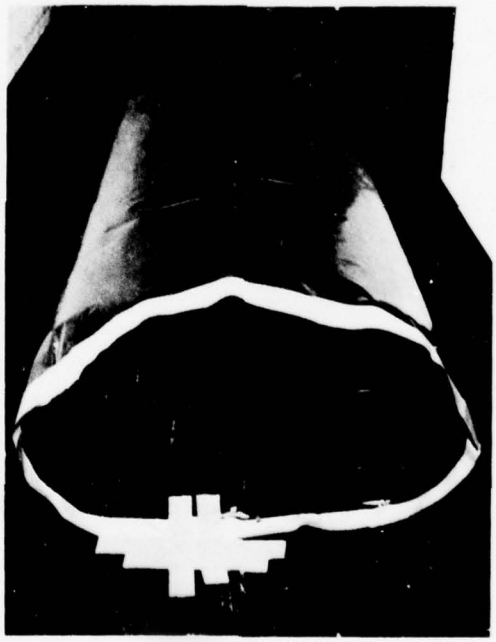


Laying Out Duct

- Without leaving shelter, unroll remaining duct and cut to size. Be sure to cut off enough duct for sealing purposes.

- Use duct tape to form a complete ring around free end to prevent tearing.

- Leave shelter to extend duct 12 feet past outside opening; adjust location of Ventilator if necessary. Tape down bottom of free end with several strips of duct tape, as shown below. Save excess tape and return to shelter as quickly as possible.



- Check duct and straighten out sharp bends.

- Use excess duct material and duct tape to make seals for windows, doors or around duct. Cut and tape material to form air-tight seal.

Operating Pedal Ventilator Manually

- If ventilator is pedalled, pedal at one revolution each second, as if you were riding an ordinary bicycle.

- Operate the ventilator continuously and keep children away.

Duct

- When ventilator is operating, duct must be inspected periodically for leaks which must be sealed with duct tape.

- Prevent duct damage by keeping people away from it.

APPENDIX C

KEARNY PUMP KIT

MILITARY SPECIFICATIONS

LIMITED COORDINATION

MILITARY SPECIFICATION

VENTILATOR KIT, FLAP AIR PUMP (KEARNY TYPE, KPK)

This limited coordination military specification has been prepared by the Defense Civil Preparedness Agency based upon currently available technical information, but it has not been approved for promulgation as a coordinated military specification. It is subject to modification. However, pending its promulgation as a coordinated military specification, it may be used in procurement.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers the fabrication, assembly, performance and packaging of one type of complete ventilation kit for use in fallout shelters (see Figures 1 and 2) and consists of a number of components which can be assembled in any standard doorway.

1.2 Classification. The Kearny pump ventilator kit shall be of one type as specified. The kit contains swinging louvered pump frames which can be mounted in a doorway using the doorway support bar.

2. APPLICABLE SPECIFICATIONS, STANDARDS, DRAWINGS AND OTHER PUBLICATIONS

2.1 Specifications and Standards. The following specifications and standards of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

L-P-378a	Plastic Film (Polyethylene Thin Gage)
MMM-A-250	Adhesive, Water-resistant, (For Sealing Fiberboard Boxes)
PPP-B-636H	Box, Fiberboard
PPP-B-1163B	Box, Corrugated Fiberboard, High Compression Strength, Weather-resistant, Wax And Resin Impregnated
PPP-T-45	Tape, Gummed, Paper, Reinforced And Plain, For Sealing And Securing
PPP-T-76	Tape, Pressure-sensitive Adhesive Paper, Water Resistant, (For Carton Sealing)
QQ-Z-325C	Zinc Coating, Electrodeposited, Requirements For
UU-P-268	Paper, Kraft, Untreated, Wrapping

Military

MIL-B-131	Barrier Material, Water Vaporproof, Flexible
MIL-C-5541	Chemicals Films And Chemical Film Materials For Aluminum And Aluminum Alloys
MIL-P-116	Preservation, Methods Of

STANDARDS

Military

MIL-STD-105D	Sampling Procedures And Tables For Inspection By Attributes
MIL-STD-129F	Marking For Shipment And Storage
MIL-STD-171C	Finishing Of Metal And Wood Surfaces

(Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge at the General Services Administration Regional Offices in Boston, New York, Atlanta, Chicago, Kansas City, Mo.; Dallas, Denver, San Francisco, Los Angeles, Seattle and Washington, D.C. Copies of the military specifications and standards required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

2.2 Drawings. The ventilator kit consists of a Kearny pump (top and bottom sections), an A-frame support and a doorway support bar.

2.2.1 Kearny Pump

1477E3000	Frame Assy, Kearny Pump
D3010	Frame, Top Section, Kearny Pump
D3015	Frame, Bottom Section, Kearny Pump
C3020	Flap Components, Kearny Pump
C3030	Components, Kearny Pump
A3035	Hinge Pin, Kearny Pump
B3040	Tie Plate, Kearny Pump
B3042	Pull Cord, Kearny Pump
B4007	Decals

2.2.2 Doorway Support Bar

1477D2000	Support Bar Assy, Doorway Kearny
C2010	Support Tubes, Doorway Kearny
C2020	Support Components, Doorway Kearny
B2030	Bearing Support, Outer Tube, Doorway Kearny
B2031	Bearing Support, Inner Tube, Doorway Kearny
A2050	Crutch Tip, Doorway Kearny

(Copies of drawings required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Drawings. Unless otherwise specified herein, the materials and assembly thereof shall be as shown on the drawings, (see 2.2); however, minor changes will be allowed. Any minor change or substitution of materials must not affect the rigidity of the unit or the performance requirements specified herein and must be approved by the contracting officer. Drawings are furnished for contractor guidance and information purposes only to illustrate details of the required equipment. While every precaution has been taken to assure their accuracy, the contractor is responsible for dimensional adequacy and accurate fits for proper equipment assembly, alignment, and operation.

3.1.1 Contents of a Complete Kearny Pump Kit shall be as follows:

Box A

(a) Kearny pump frame, two sections.
Complete as per Dwg. 1477E3000, with the exception that the two sections shall be separated and the two tie plates swung down and retained on the lower flap section with thumbscrews. All thumbscrews required for assembly of the two sections shall be provided.
(b) Doorway support bar, one.
Complete as per Dwg. 1477D2000.
(c) Pull cord, two.
Complete as per Dwg. 1477B3042.
(d) KPK instruction booklet, three copies.

3.1.2 Metal Fabrication. Metal used in the fabrication of the equipment shall be free from kinks. The straightening of material shall be done by methods that will not cause injury to the metal. Shearing and chipping shall be done neatly and accurately. Corners shall be square and true.

3.1.3 Machine Work. Tolerance and gages for metal fits shall conform to the limitations specified herein and otherwise to the standards of best commercial practice. Finished contact and bearing surfaces shall be true and exact. Adequate gages shall be utilized to assure proper bearing fit, interchangeability, alignment and squareness.

3.1.4 Bolted and Screwed Connections. Bolt holes shall be accurately punched or drilled and shall have the burrs removed. Tapped holes shall be tapped to class of fit specified on the drawing; all metal chips resulting from this operation shall be removed.

3.1.5 Welding. The surfaces of parts to be welded shall be free from rust, scale, paint, grease and other foreign matter. Welds shall develop adequate strength in the parts connected.

3.1.6 Finishing. Major units and subassemblies shall be finished as specified herein or on drawings.

3.2 Accessories.

3.2.1 Instructions. Each kit shall be supplied with six KPK instruction booklets. This publication will be furnished by the Defense Civil Preparedness Agency at the time of contract award.

3.3 Lubrication. All porous bronze bearings shall be impregnated with a high grade oxidation resistant mineral oil of SAE30 viscosity.

3.4 Finish.

3.4.1 Kearny Air Pump.

3.4.1.1 Steel Components. Zinc plate per QQ-Z-325, Type II, Class 2 with clear chromate treatment.

3.4.1.2 Netting. Commercial galvanize.

3.4.1.3 Aluminum Frames and Tie Plates. Chemical conversion coat in accordance with MIL-C-5541, Class 1.

3.4.2 Doorway Support Bar.

3.4.2.1 Steel Components. Zinc plate per QQ-Z-325, Type II, Class 2 with clear chromate treatment.

3.4.2.2 Aluminum Bearing Support. Chemical conversion coat in accordance with MIL-C-5541, Class 1.

3.5 Marking. The identification of the items shall be made on the container in conformance with MIL-STD-129. Specific markings on the ventilator unit shall be made by decalcomanias applied per instructions on the decal prints.

3.6 Workmanship. All materials used in the unit shall be of good commercial quality, entirely suitable for the purpose intended. The units shall be constructed and finished in a thoroughly workmanlike manner. Particular attention shall be given to neatness and thoroughness of machining, fitting of parts, welding, and marking of assemblies. Visual defects shall be cause for rejection.

3.7 Preproduction Sample. When specified in the contract or order (see 6.2) before production is commenced, a sample kit shall be submitted or made available to the contracting officer or his authorized representative for approval in accordance with 4.2. The approval of the preproduction sample authorizes the commencement of production, but does not relieve the supplier of responsibility for compliance with all applicable provisions of this specification. The preproduction sample shall be manufactured in the same facilities to be used for the manufacture of the production item.

4. QUALITY ASSURANCE PROVISIONS

4.1 Inspection Responsibility. The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Preproduction Sample Inspection. When a preproduction sample is required (see 3.7), it shall be examined in accordance with applicable paragraphs of Section 3 and Section 4 (with laboratory tests at the contractor's expense).

4.3 Production Inspection.

4.3.1 Performance. The inspector shall ascertain that the units meet the performance requirements specified herein.

4.3.2 Workmanship. The units shall be inspected for rigidity, alignment, interference of components, interchangeability of components, finish, color and marking.

4.3.3 Packing and Marking. The inspector shall ascertain that the packing and marking of the containers conform to this specification.

4.3.4 Packaging. Cleanliness, leakage, and heat seal tests are required per MIL-P-116, Table 3.

4.4 Quality Conformance Inspection.

4.4.1 Lot. A lot shall consist of one day's production or all units offered for acceptance at one time.

4.4.2 Sampling.

4.4.2.1 Sampling for Examination. Sampling for examination shall be in accordance with MIL-STD-105. For major defects the AQL shall be 2.5 percent defective units, at inspection Level II. For minor defects, the AQL shall be 6.5 percent at inspection Level I (or S_2 for standard parts). Each minor characteristic shall be considered separately for acceptance of the lot.

4.4.2.2 Sampling for Tests. Sampling for tests shall be in accordance with MIL-STD-105, at inspection Level II. The AQL shall be 1.0 percent defective.

4.4.3 Examination. Each unit selected in accordance with 4.4.2.1 shall be examined for defects listed in Table I. Any unit having one or more major defects shall be considered a defective unit.

Table I

CLASSIFICATION OF DEFECTS

Category	Defect
Major	
101	Packaging not acceptable; equipment could be damaged or small parts lost.
102	Package marking not as specified.
103	Hinge pins not properly lined up on the Kearny pump frame.
104	Bearing supports will not slide over tubes on the adjustable doorway bar.
105	Tube will not telescope on the adjustable doorway support bar.
106	Components or hardware missing, including the KPK instruction booklets.
107	Welds not acceptable.
108	Material not as specified.
109	Dimensions not as specified.
110	Metal fabrication not suitable.
111	Fasteners and pins not as specified.
112	Workmanship not acceptable.
113	Finish not as specified or acceptable.
114	Preservation not as specified.
Minor	None defined.

4.4.4 Functional Tests. Samples selected in accordance with 4.4.2.2 shall be tested as specified herein. Any sample failing to pass any test shall be considered a defective unit.

4.4.4.1 Kearny Pump.

4.4.4.1.1 Assemble top and bottom sections together using tie plates.

4.4.4.1.2 Install a top and bottom section into a fixture which would serve to indicate the correct alignment of the hinge pins.

4.4.4.2 Doorway Support Bar.

4.4.4.2.1 Install the doorway support bar in the minimum and maximum door openings as specified on print 1477D2000, to check overall dimensions.

4.4.4.2.2 Slide each bearing support along the length of the tubes to check for free sliding fit.

4.5 Inspection of Preparation for Delivery. The preservation, packaging, packing and marking shall be inspected to determine compliance with the requirements of Section 5 of this specification.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging of the Kearny pump, the doorway support bar and accessories.

5.1.1 The following preservation procedures in conformance with MIL-P-116 shall be effected.

5.1.1.1 Intermediate packing of accessories for the Kearny pump and the doorway support bar.

5.1.1.1.1 KPK Instruction Booklet. KPK instruction booklets, 6 copies (see 3.2.1), shall be preserved and packaged, 3 copies per packet, per method IC-3 of MIL-P-116. The transparent heat sealed bag shall be fabricated from material conforming to L-P-378. The message and its placement on the plastic bag shall be as shown in Figure 3.

5.1.1.1.2 Pull Cord. The pull cords (2 per package) shall be preserved and packaged per method IC-3 of MIL-P-116. The transparent heat sealed bag shall be fabricated from material conforming to L-P-378.

5.1.1.2 Doorway Support Bar. The doorway support bar shall be packed in a style FPF, Type CF, Class Domestic, Variety SW, Grade 125 box fabricated and closed in conformance with PPP-B-636. Approximate inside dimensions shall be 30-1/4 inches long by 4-3/4 inches wide by 2 inches deep. The box shall be closed with gummed paper tape 3 inches wide conforming to PPP-T-45. The contents of the box shall be marked (1/2 inch letters) on one of the large panels of the box.

5.1.1.3 Kearny Pump Interior Box. The Kearny pump shall be packed in conformance with method IA-14 of MIL-P-116. The interior box shall be Style FOL, Type CF, Class Domestic, Variety SW, Grade 125, fabricated and closed in conformance with PPP-B-636. Approximate inside dimensions shall be 30-3/4 inches long by 5 inches wide by 41 inches deep. The box shall be closed by gummed paper tape conforming to PPP-T-45. The two Kearny pump frames shall be packed face to face with appropriate inner packing forms on the face and sides of the Kearny frames to separate them, and protect the hinge wires and clips and prevent wrinkling or creasing of the plastic flaps.

The Kearny pump (one top and one bottom section) shall be inserted into the packing box with the bearing support lugs toward the top. The pull cord packet shall be placed on top of the Kearny pump sections between the bearing support lugs. The packet of the KPK instruction booklet (3 copies) shall be securely wrapped and taped to the doorway support bar container (see 5.1.1.2) and the container placed in the box on top of the Kearny pump. The placement of the doorway support bar box shall be such that the instruction booklets are instantly visible when the top flaps of the interior container are opened.

5.1.1.3.1 Barrier Bag. The packed interior box shall be enclosed in a close fitting heat sealed bag fabricated from barrier material conforming to MIL-B-131, Class 1.

5.1.1.3.2 Exterior Box (Box A) The bagged interior box shall be packed in a Style OSC, Class I, Type SWCFI, Grade 250 box, wax-resin impregnated in conformance with PPP-B-1163. The approximate inside dimension shall be 31-3/4 inches long by 5-1/2 inches wide by 42 inches deep. The exterior of the box shall be marked as per 5.2.

5.1.1.3.3 Closure. The flaps of the box specified in 5.1.1.3.2 shall be securely sealed with water resistant adhesive conforming to MMM-A-250. In addition, the seams shall be sealed by the application of a minimum 3 inch wide pressure-sensitive tape conforming to PPP-T-76. The strip of tape shall overlap each panel a minimum of 6 inches.

5.2 Marking of Exterior Boxes.

5.2.1 Box A. The box containing the Kearny pump and the doorway support bar shall be marked as per Figure 4. The lettering shall be in yellow and of Gothic style.

6. NOTES

6.1 Intended Use. Kearny pump ventilator kits are intended for use in fallout shelters to distribute the ventilation air to maintain thermal and atmospheric control of the shelter's environment. Components are provided to permit use of the ventilator kits for both doorway or window use.

6.2 Ordering Data. Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Number of assemblies required.
(c) Contact point for KPK instruction booklets. (See 3.2.1).
(d) Listing of serial numbers. (See 5.2).
(e) Whether preproduction sample is required. (See 3.7).

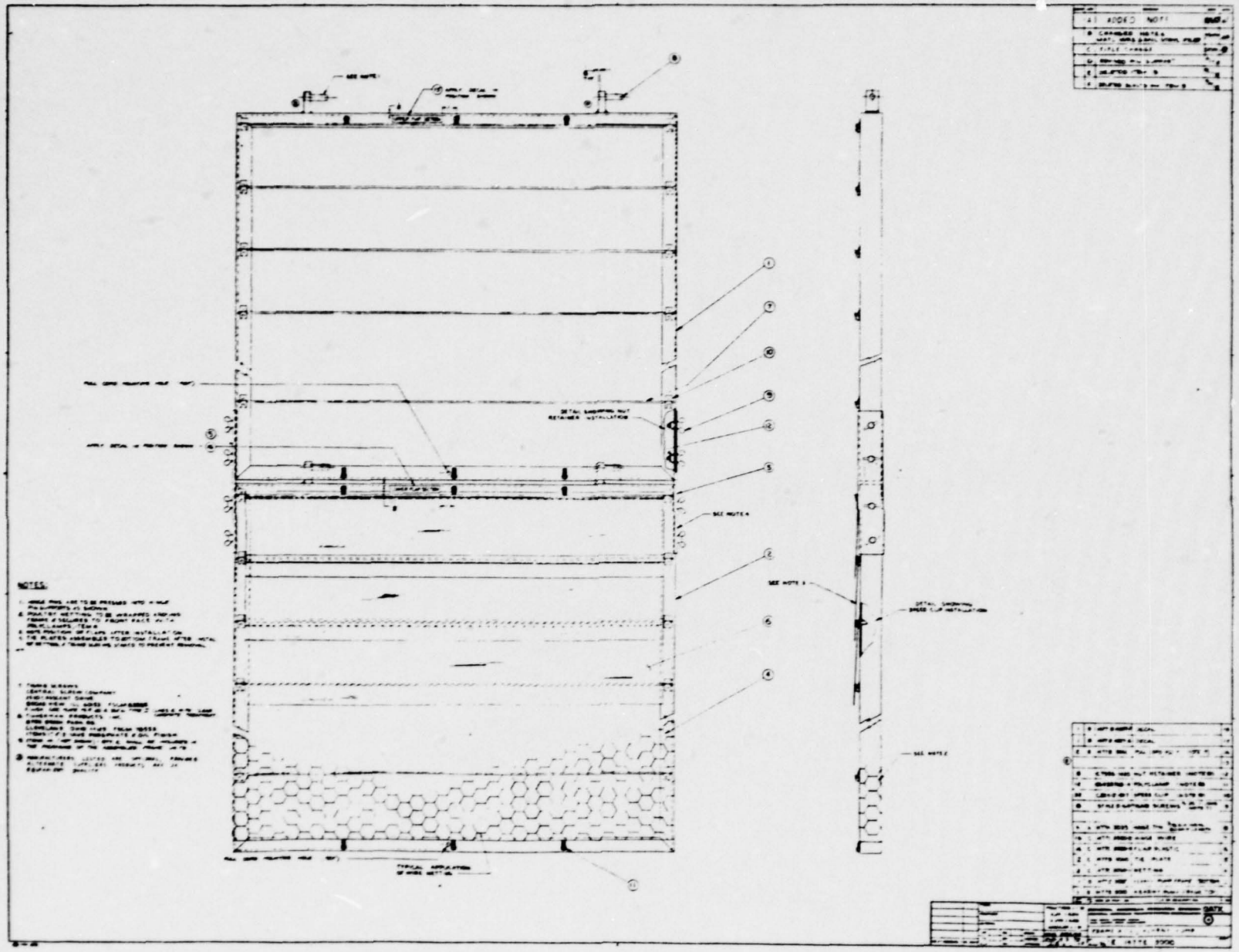
Notice. When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodian:

Defense Civil Preparedness Agency

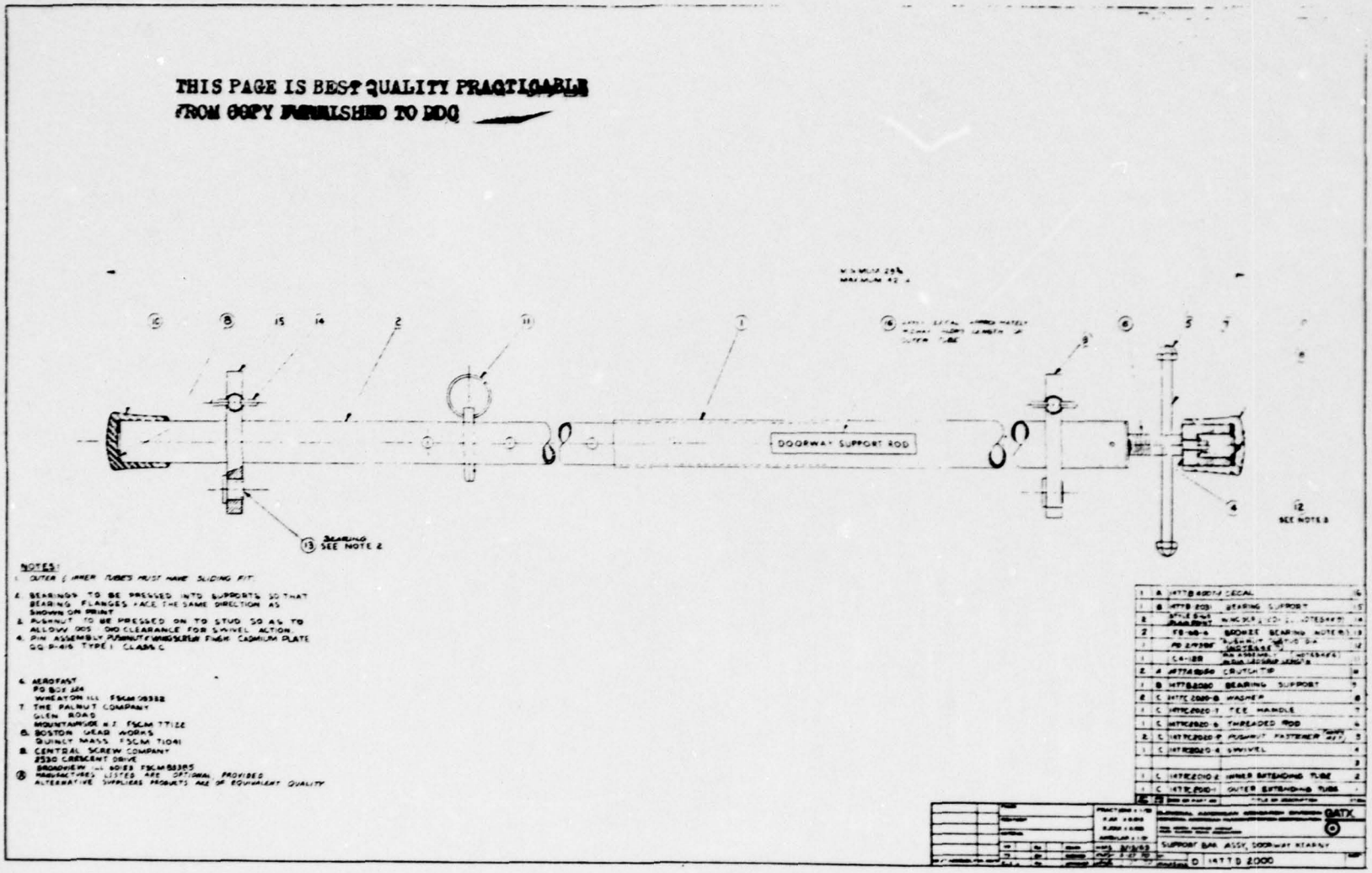
Preparing Activity:

Defense Civil Preparedness Agency



VENTILATOR KIT, FLAP AIR PUMP (KEARNY TYPE, KPK)

Figure 1



DOORWAY SUPPORT BAR ASSEMBLY

Figure 2

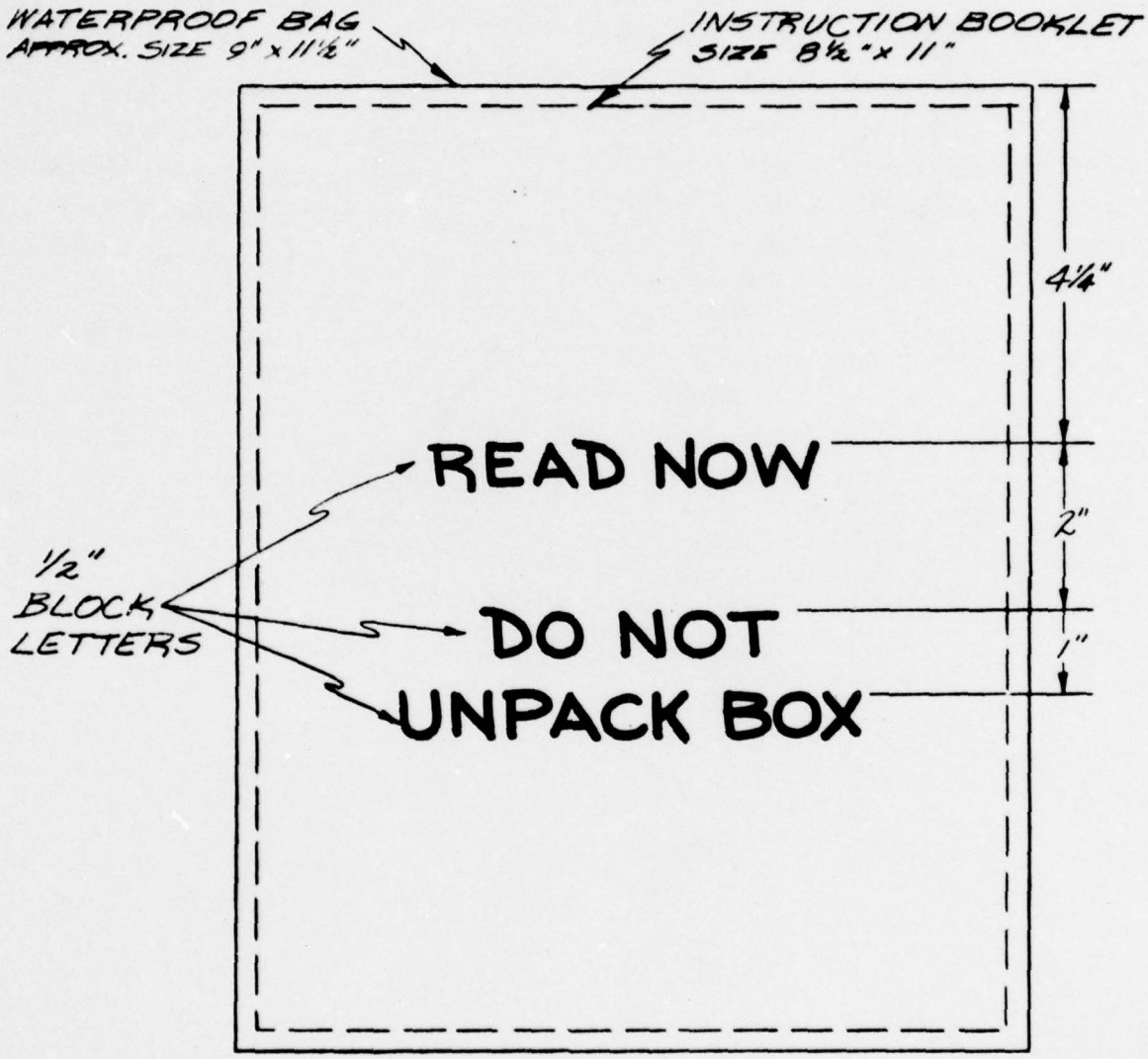


Figure 3 MESSAGE MARKING ON WATERPROOF
PVK INSTRUCTION BOOKLET BAG

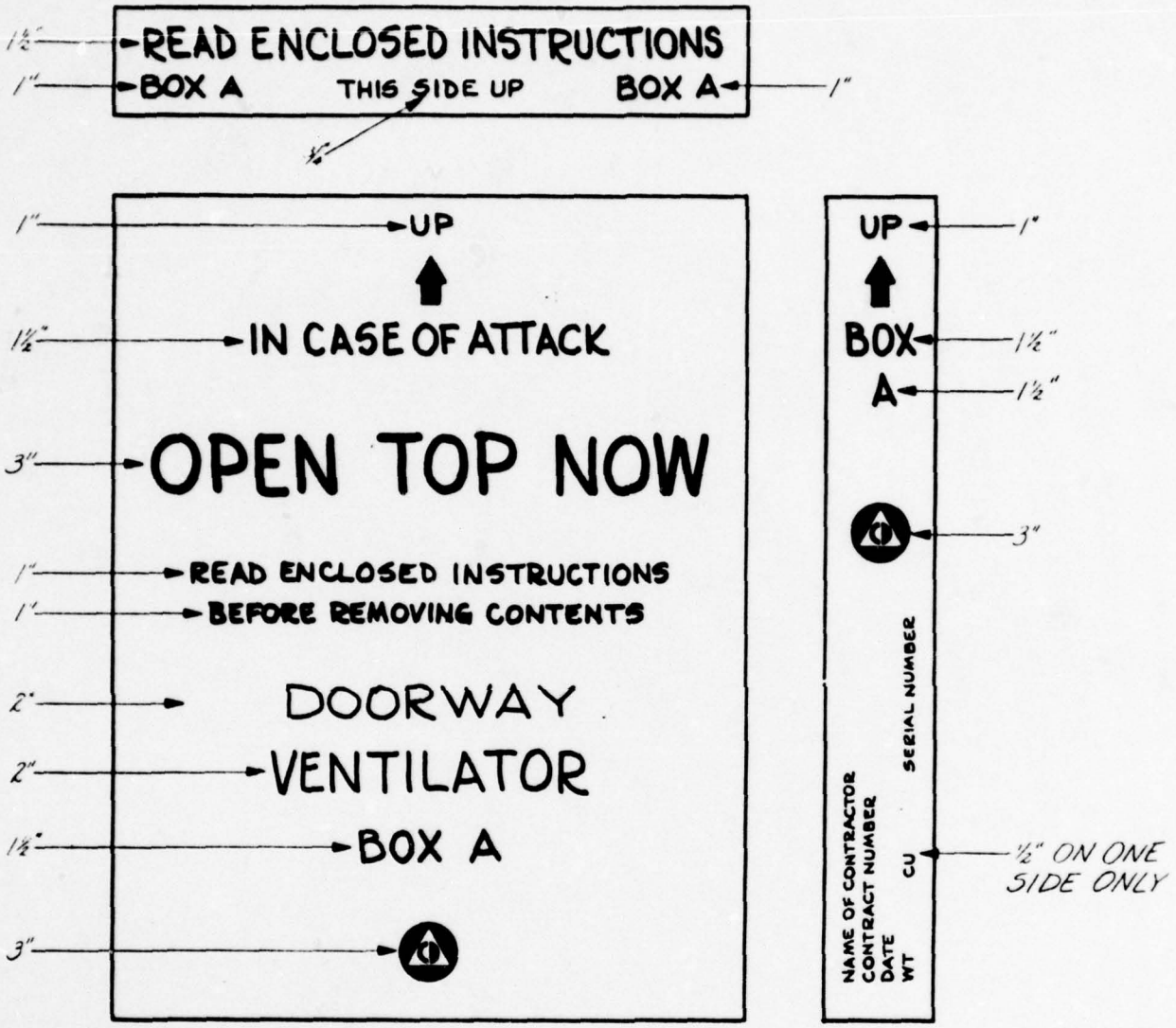


Figure 4 EXTERIOR BOX MARKINGS, BOX A

APPENDIX D

KEARNY PUMP KIT

OPERATING INSTRUCTIONS

DOORWAY VENTILATOR INSTRUCTIONS

LOCATION — ASSEMBLY — OPERATION

LIFE SAVING INFORMATION

DO NOT UNPACK VENTILATOR UNTIL INSTRUCTIONS SAY TO.

YOU MUST DETERMINE THE LOCATION OF THE VENTILATOR NOW, OR THE GREAT NUMBER OF PEOPLE MAY CAUSE THE SHELTER TO BECOME TOO HOT TO OCCUPY WITHIN ONE HOUR.

READ INSTRUCTIONS PAGE BY PAGE AT ONCE

THEN FOLLOW THESE STEPS:

1. DETERMINE VENTILATOR LOCATION
2. MOVE BOX TO LOCATION
3. UNPACK BOX
4. ASSEMBLE VENTILATOR
5. OPERATE VENTILATOR CONTINUOUSLY

OFFICE OF CIVIL DEFENSE
OFFICE OF THE SECRETARY OF THE ARMY

The three people holding these Doorway Ventilator Instructions must form a Doorway Ventilator Team.

Each team member must read the instructions now and follow all directions.

Decide any questions by talking it over and voting.

Should a Shelter Manager be present, follow his orders.

READ CAREFULLY

- The fallout shelter you are in may have one room or a number of rooms and areas together. You may have to stay in this shelter for several days or longer.

- Use the Doorway Ventilator to bring fresh air into the shelter

  and/or

  distribute fresh air to parts of the shelter.

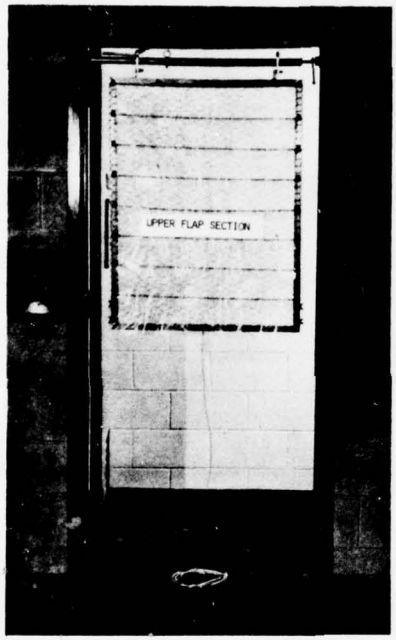
- Incoming fresh air will be safe! After Ventilator is operating, if you are uncertain about radiation effects and shelter ventilation, use appendices at back of booklet.
  NOT NOW!

THE DOORWAY VENTILATOR IS PACKED IN BOX A.

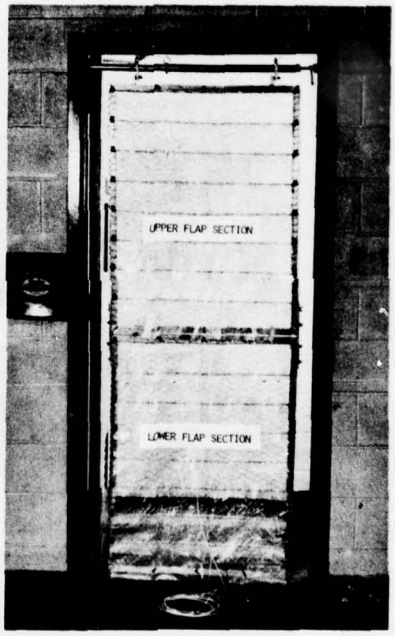
READ LABELS ON ALL VENTILATOR BOXES TO BE SURE THAT BOX A IS IN SHELTER.

DO NOT UNPACK BOX YET

PHOTOGRAPHS OF ASSEMBLED VENTILATORS ARE SHOWN ON NEXT TWO PAGES. STUDY THEM.


UPPER FLAP SECTION

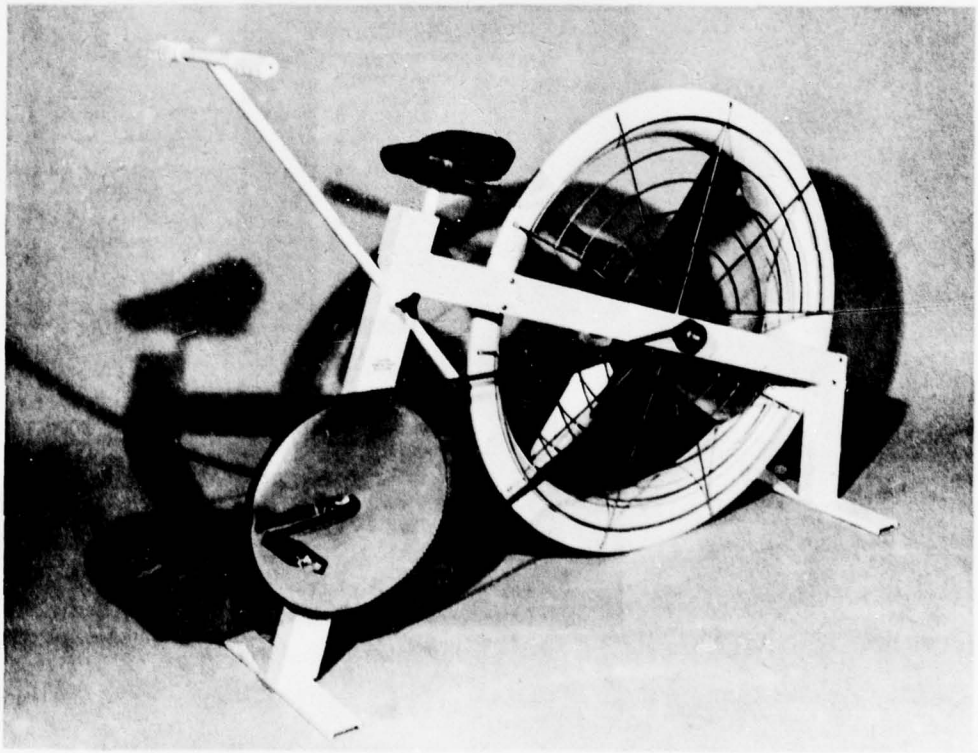
BOTH FLAP SECTIONS CAN BE ATTACHED TOGETHER AND HUNG IN A DOORWAY, AS SHOWN BELOW.



DOORWAY VENTILATOR
with <u>both</u> Flap Sections attached (view from inside room).

READ LABELS ON ALL VENTILATOR BOXES TO CHECK FOR A PEDAL VENTILATOR (SHOWN BELOW).

IF IT IS IN SHELTER, READ PAGES 7 TO 9, WHICH FOLLOW.
IF NOT, SKIP TO PAGE 10.



PEDAL VENTILATOR

WHERE TO LOCATE

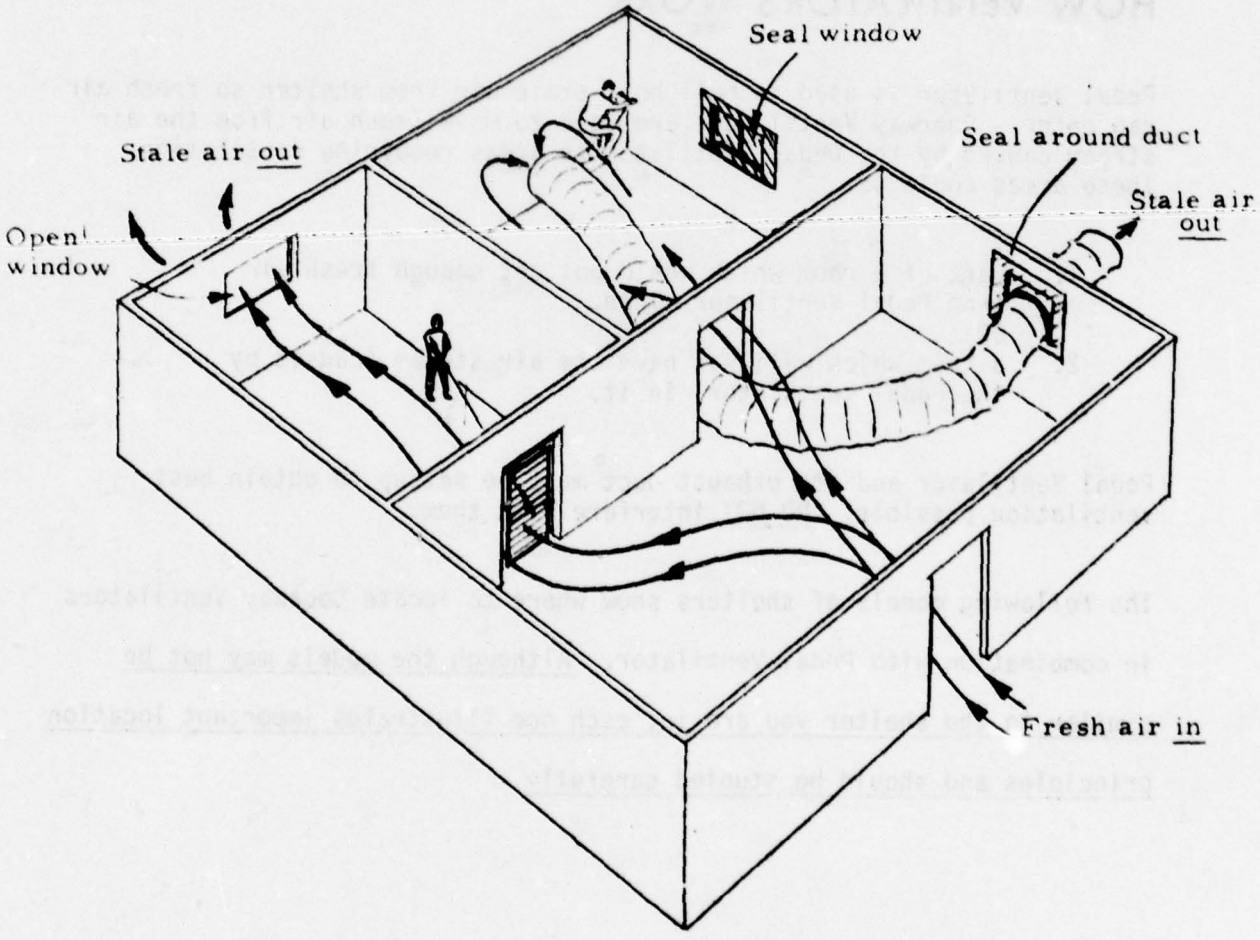
1. To ventilate a side room which will not have the air stream (caused by the Pedal Ventilator) in it:

   Use a Doorway Ventilator with:

   - two Flap Sections, if the room has two or more openings
   - one Flap Section, if the room has only one opening (see next page).

   Place Doorway Ventilator in doorway.

   Point Flap Section so that Flaps face into room to be ventilated.



DETERMINE BEST LOCATION FOR VENTILATOR

INSTRUCTIONS FOR DOORWAY VENTILATORS WHEN USED WITH PEDAL VENTILATOR

DO NOT UNPACK VENTILATORS YET

HOW VENTILATORS WORK

Pedal Ventilator is used to pull hot, stale air from shelter so fresh air can enter. Doorway Ventilators are used to move fresh air from the air stream caused by the Pedal Ventilator to areas requiring ventilation. These areas could be:

1. part of a room which would not get enough fresh air from Pedal Ventilator alone,
   OR
2. a room which will not have the air stream (caused by the Pedal Ventilator) in it.

Pedal Ventilator and its exhaust duct must be set up to obtain best ventilation possible. DO NOT interfere with them.

The following models of shelters show where to locate Doorway Ventilators in combination with Pedal Ventilator. Although the models may not be similar to the shelter you are in, each one illustrates important location principles and should be studied carefully.

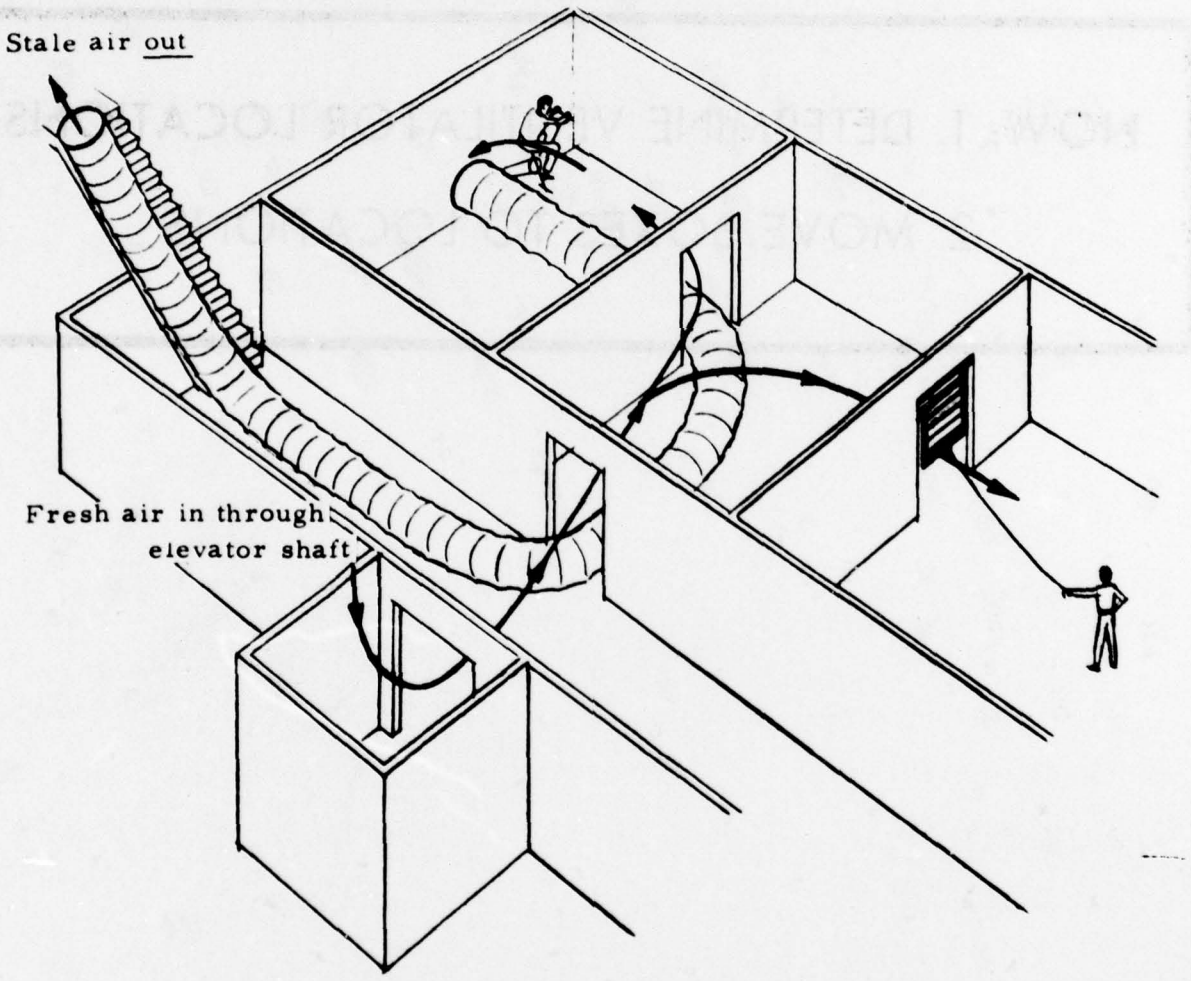
This model also shows how to ventilate a side room which will not have the air stream (caused by the Pedal Ventilator) in it.

Use a Doorway Ventilator with:

- one Flap Section, if the room has only one opening

Place Doorway Ventilator in doorway.

Point Flap Section so that Flaps face into room to be ventilated.



NOW: 1. DETERMINE VENTILATOR LOCATIONS

2. MOVE BOXES TO LOCATIONS

DETERMINE BEST LOCATIONS FOR VENTILATORS

INSTRUCTIONS FOR DOORWAY VENTILATOR WHEN USED ALONE.

DO NOT UNPACK VENTILATOR YET

HOW VENTILATOR WORKS

1. Doorway Ventilators are used to:

   a. pull fresh air into shelter, and/or to

   b. distribute incoming fresh air to parts of shelter.

2. There must be at least one opening from the outside (window, doorway, etc.) so that fresh air can enter shelter.

3. You must set up your ventilation system to make fresh air paths go through as much of the shelter as possible. To learn how to do this, read every word of the following section. THIS IS VITAL!

WHERE TO LOCATE

PRINCIPLES

1. To pull fresh air into a shelter,

   Use a Doorway Ventilator with:

   - two Flap Sections, if there are two or more shelter openings to the outside.

     OR

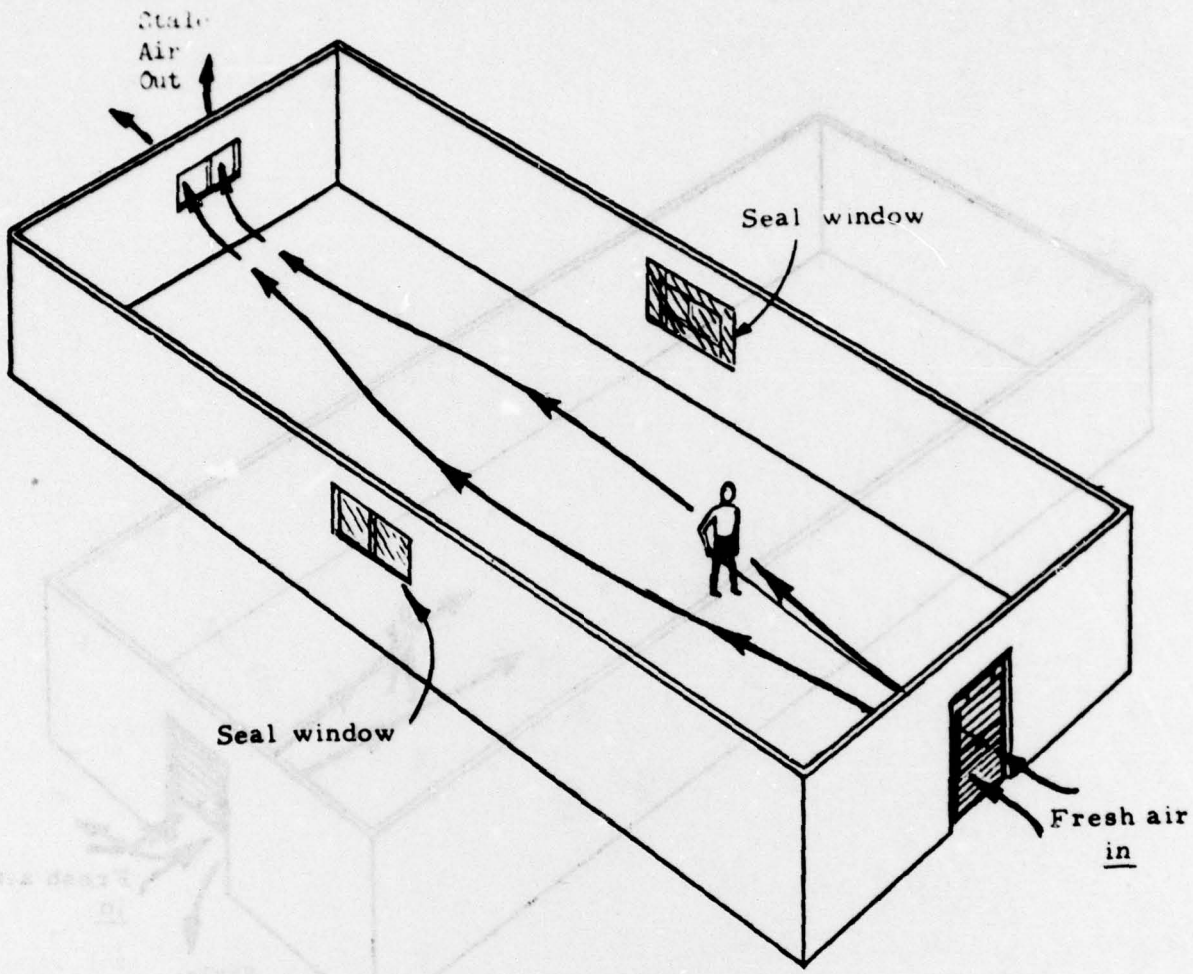
   - one Flap Section, if there is only one shelter opening to the outside.

   Place Doorway Ventilator in the doorway:

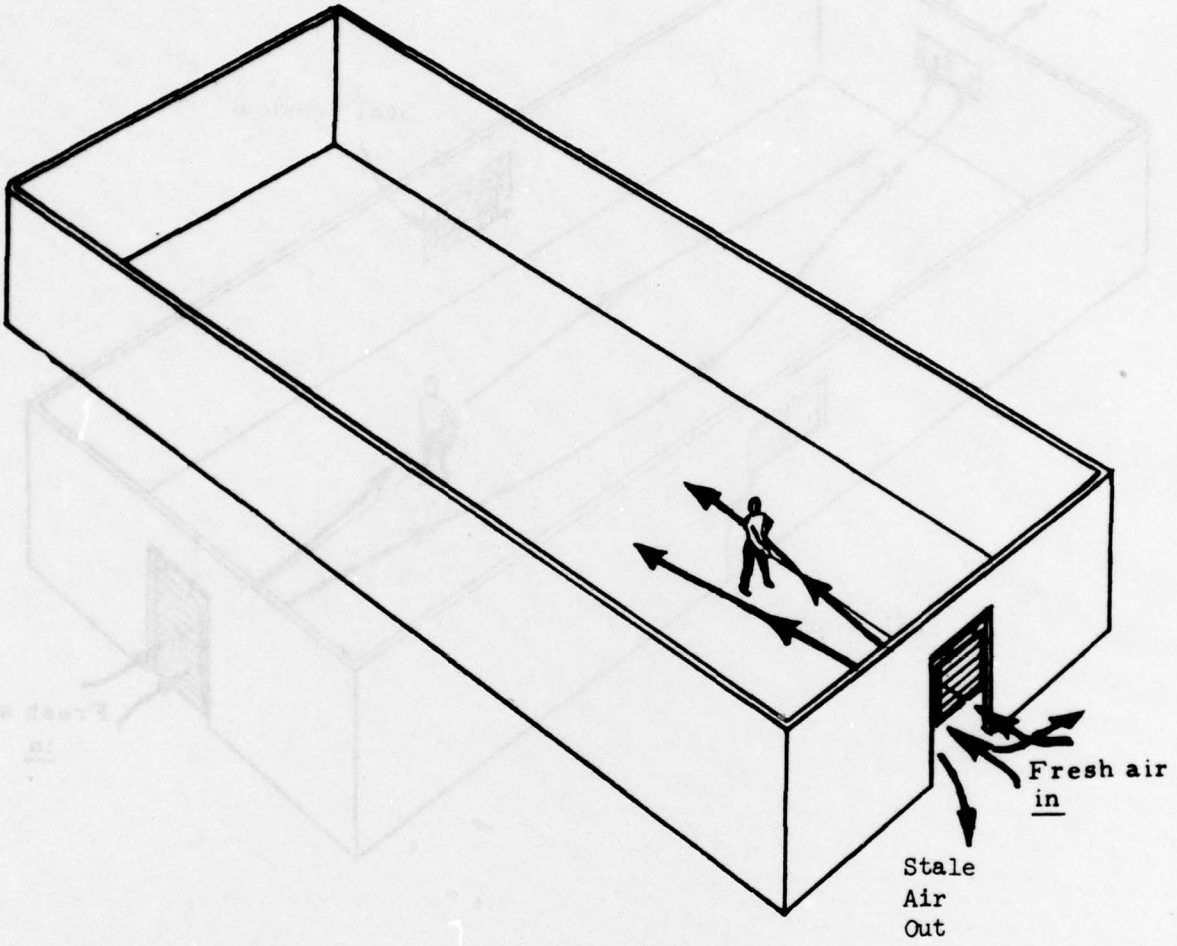
   Attach Flap Section(s) so they face into the shelter.

   Seal all but the two openings which will form the longest flow path.

The following models of shelters differ in arrangement of outside openings and rooms. This arrangement determines the location of Doorway Ventilators for best air flow. Although models may not be similar to the shelter you are in, each one illustrates important location principles and should be studied carefully.



- A Doorway Ventilator with two Flap Sections is used to pull fresh air <u>in</u> through doorway.
- Two side windows are sealed to create longest possible flow path.
- Flaps face <u>into</u> shelter.



- A Doorway Ventilator with only one Flap Section is used <u>to pull</u> fresh air <u>into</u> shelter.
- Flaps face <u>into</u> shelter.

NOW, FIND

-- SHELTER BOUNDARIES

-- ALL FRESH AIR OPENINGS

THEN:

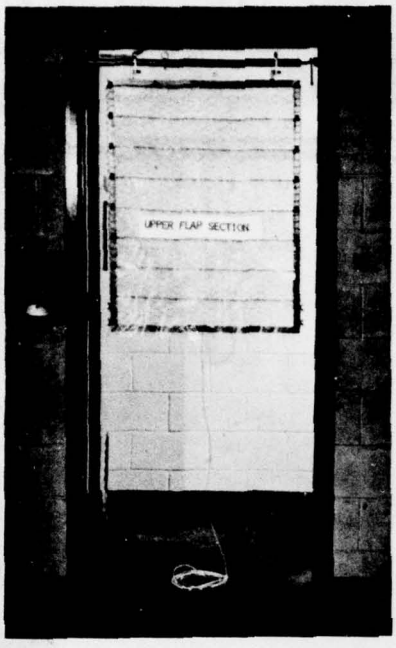
1. DETERMINE VENTILATOR LOCATION
2. MOVE BOX TO LOCATION

ASSEMBLY INSTRUCTIONS

FOLLOW CAREFULLY!

AFTER YOU HAVE PLACED
ALL VENTILATOR BOXES
IN PROPER LOCATIONS,
UNPACK AND ASSEMBLE THEM
USING THESE INSTRUCTIONS

DOORWAY INSTRUCTIONS

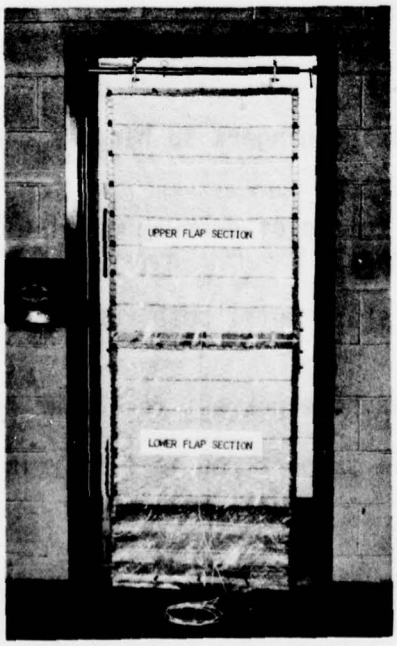


Doorway Ventilator

can be assembled with

the Upper Flap Section

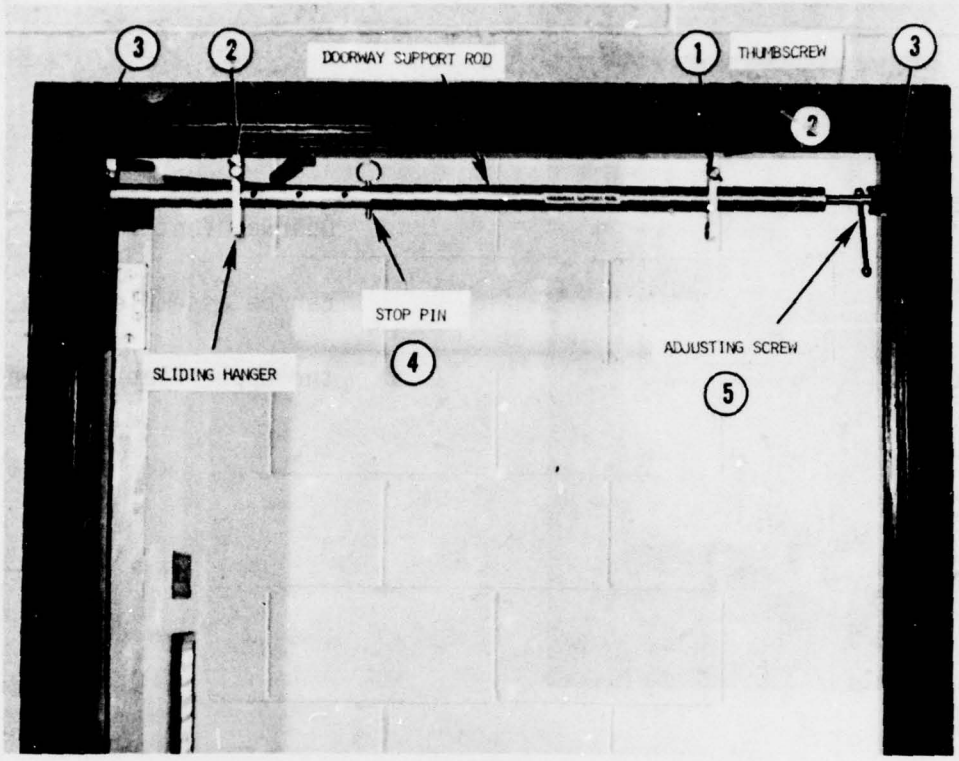
ASSEMBLED DOORWAY VENTILATORS



and, if needed, the

Lower Flap Section

can be attached



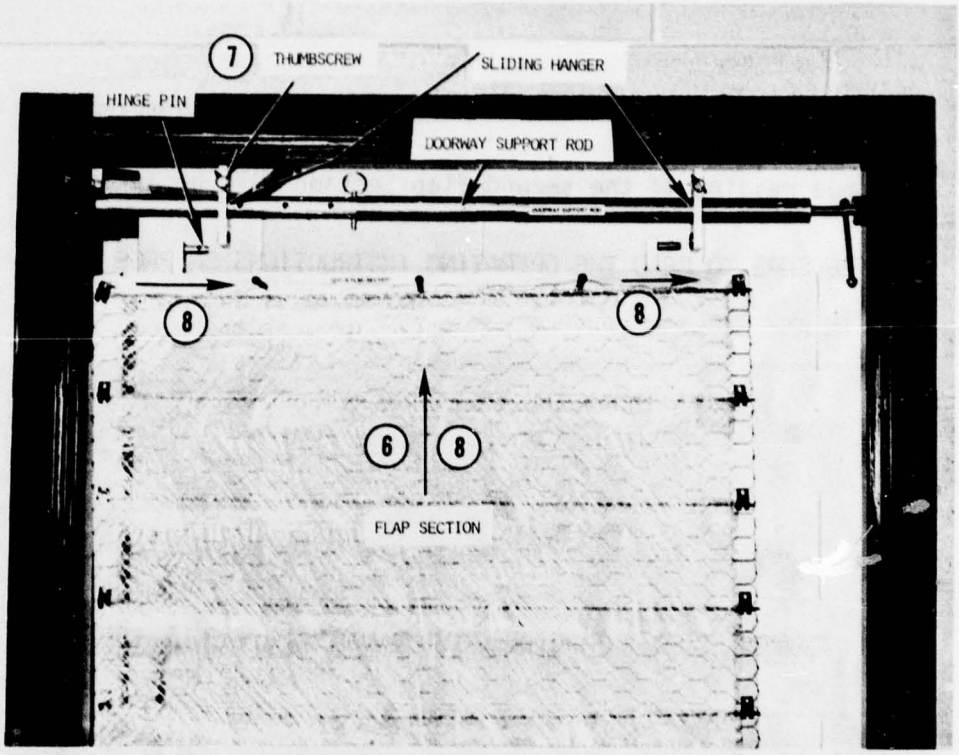
Step 1 - Loosen thumbscrews in sliding hangers so hangers can slide freely.

Step 2 - Lift doorway support rod to top of doorway until sliding hangers touch top of doorway.

Step 3 - Pull doorway support rod apart until both rubber ends are against door frame.

Step 4 - Insert stop pin in exposed hole nearest to larger tube.

Step 5 - Turn adjusting screw until support rod is firmly in position.



IF BOTH FLAP SECTIONS WILL BE USED ON DOORWAY VENTILATOR, FIRST ATTACH UPPER FLAP SECTION.

OTHERWISE, USE ANY FLAP SECTION.

Step 6 - Lift Flap Section to level of sliding hangers and determine position of sliding hangers which will allow Flap Section to swing freely. Slide hangers along support rod to that position.

Step 7 - TIGHTEN thumbscrews.

Step 8 - Lift Flap Section up to level of sliding hangers and push Flap Section to right until hinge pins snap through hangers.

Step 9 - Attach pull cord through hole at bottom of Flap Section

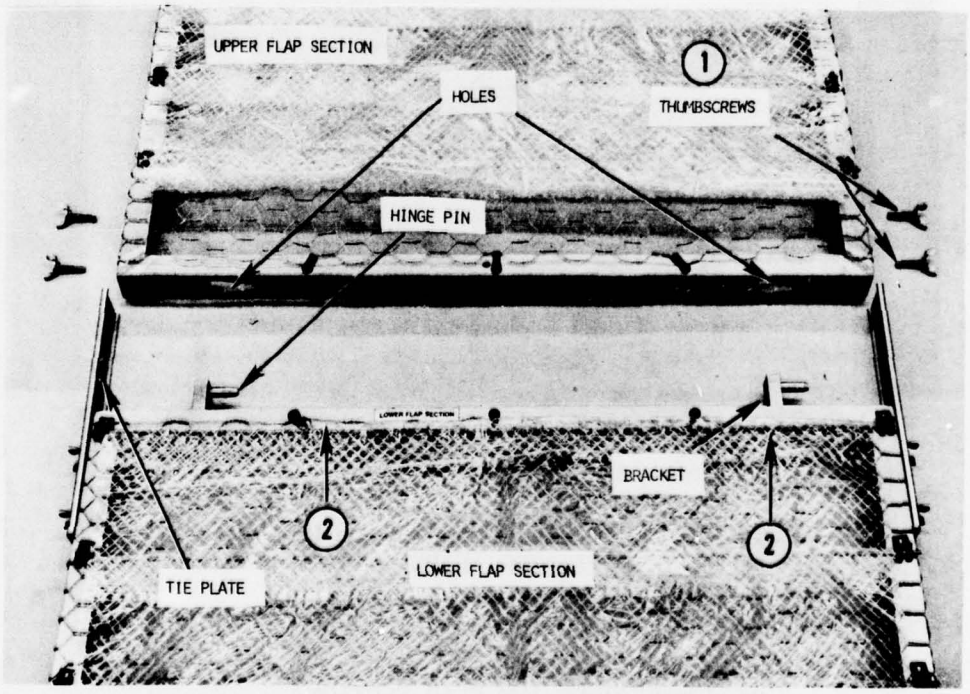
Step 10 - Slowly swing Flap Section and check for clearance.

Doorway Ventilator with one Flap Section is now assembled.

Continue reading if the second Flap Section will be attached.

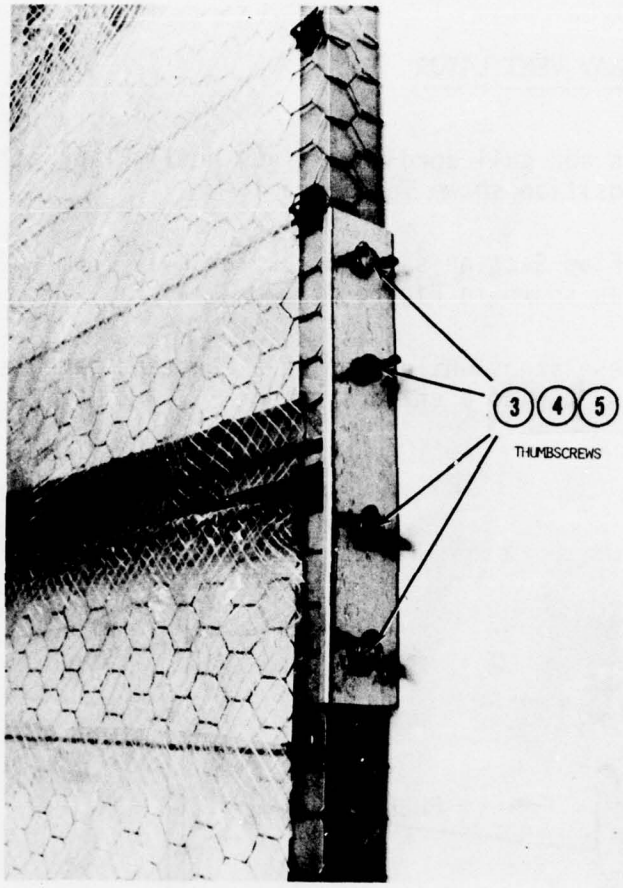
BE SURE TO READ THE OPERATING INSTRUCTIONS ON PAGE 22

IN ANY CASE.



Step 1 - Remove 4 thumbscrews at bottom of Upper Flap Section, and loosen 4 thumbscrews which hold two tie plates to Lower Flap Section.

Step 2 - Lift Lower Flap Section so that brackets and hinge pins fit through triangle-shaped holds in bottom of Upper Flap Section. The two tie plates should be aligned with the matching holes on the Upper Flap Section (2 holes each side).



Step 3 - Install 4 thumbscrews previously removed in Step 1.

Step 4 - Turn all 8 thumbscrews LOOSELY and check for a rigid connection between both Flap Sections.

Step 5 - NOW, TIGHTEN all 8 thumbscrews.

Doorway Ventilator with both Flap Sections is now fully assembled.

NOW READ <u>OPERATING INSTRUCTIONS</u>, NEXT PAGE.

OPERATING DOORWAY VENTILATOR

- Face Flaps and pull cord toward you until Flap Section(s) reaches position shown in Figure 1.
- Then let Flap Section(s) swing as far away from you as it will go, as shown in Figure 2.
- Repeat these steps while keeping a constant pace, as you would when pushing a child's swing.

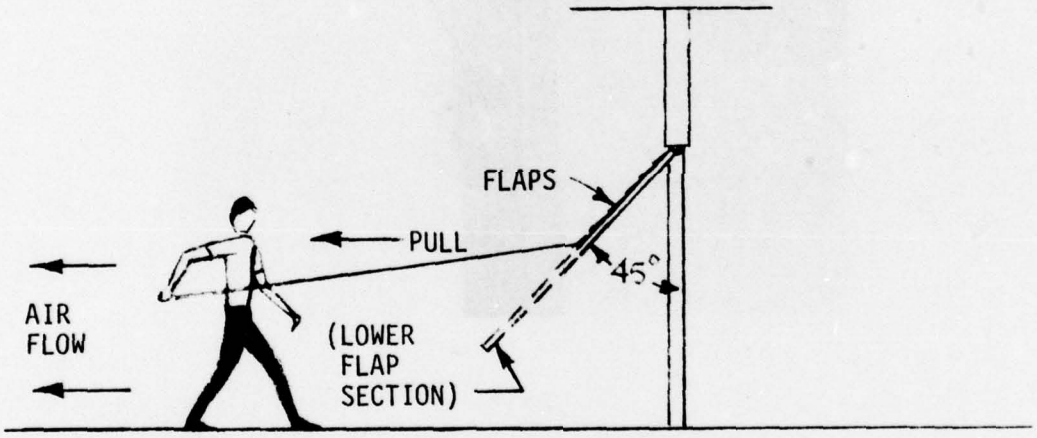


Figure 1

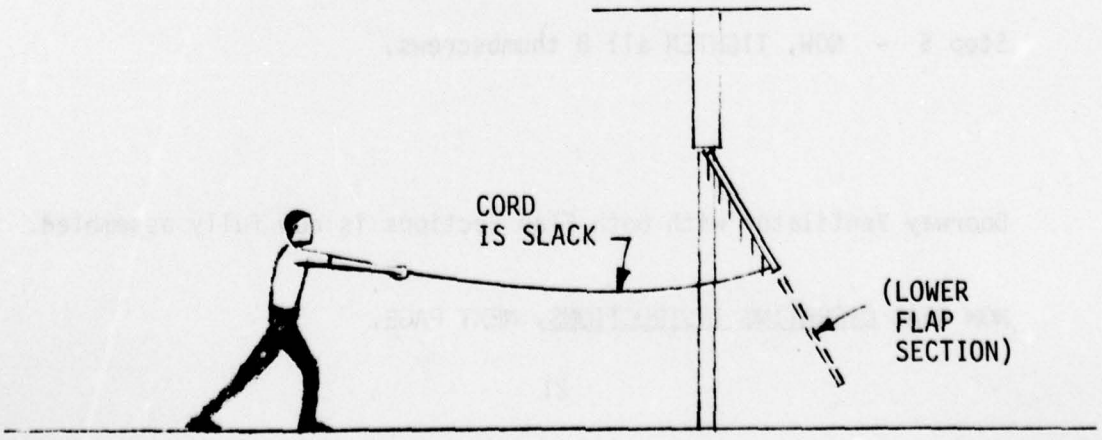


Figure 2